# SOCIAL DYNAMICS OF COOPERATION

*How Motivational Diversity, Social Contagion, Communication, and Group Formation Shape Blood Donation Behaviour.*

**Joris Melchior Schröder**

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The research reported in this thesis was conducted at the Center for Philanthropic Studies at the Department of Sociology of the Vrije Universiteit Amsterdam and the Department of Donor Medicine Research at Sanquin Research in Amsterdam, the Netherlands. Part of this research was performed during a research visit at the Department of Economics at the National University of Singapore.

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# SOCIAL DYNAMICS OF COOPERATION: HOW MOTIVATIONAL DIVERSITY, SOCIAL CONTAGION, COMMUNICATION, AND GROUP FORMATION SHAPE BLOOD DONATION BEHAVIOUR

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# Contents

# Chapter 1

# General introduction

Cooperation is a fundamental aspect of social life that is widespread in many species (Clutton-Brock 2002; Henrich and Muthukrishna 2021; Konrad et al. 2018). It can broadly be defined as a behaviour that benefits a group, potentially including the self (Ferguson 2022; West et al. 2007). Among humans, cooperation takes on remarkable dimensions and is indispensable for the provision of many public goods from small workplace collaborations to global challenges such as tackling climate change or pandemics. An ideal-typical example of cooperation are voluntary and non-remunerated (VNR) blood donations (Ferguson 2022). These donations benefit unknown and unrelated others by enabling life-saving transfusions and the production of plasma derived medicinal products. At the same time, they are personally costly in terms of time and potential inconveniences[1]. When faced with the decision whether to cooperate or not, tensions often arise between self-interest and what is best for the collective. Accordingly, there are many areas where cooperation for the provision of a public good is hard to achieve. This can also be seen in the supply of blood and blood products: While the demand for blood and blood products is large and growing, almost all countries in the world suffer from persistent or seasonal shortages of blood donations (Jaworski 2020; Roberts et al. 2019). A major challenge in research on cooperation and prosocial behaviour is therefore to identify strategies that facilitate its sustained provision.

Scholars across many disciplines, including economics, psychology, and sociology, have studied how cooperation can be sustained over time (Chaudhuri 2011; Fehr and Schurtenberger 2018; Keltner et al. 2014; Kollock 1998; Rand and Nowak 2013; Simpson and Willer 2015). To systematically study this question, we would ideally start with a minimalist rep-

[1] Because of the high immediate costs of donation and little immediate direct benefit, blood donations are also often considered a prosocial behaviour, defined as a behaviour that benefits others at some personal cost (Wittek and Bekkers 2015). This is synonymous to the social science definition of altruism or altruistic behaviour (Andreoni 1990; Ferguson and Lawrence 2016).

resentation of cooperation and observe how cooperative behaviour develops with changes to the minimalist setup. This is exactly what laboratory experiments of cooperation and prosocial behaviour have been doing for decades (Kollock 1998). In the most basic setting[2], each individual is given an initial endowment, and individuals then privately choose how much of their resources to contribute to a public account and to keep for themselves. The resources in the public account are multiplied by a factor larger than one, and the resources in the public account are then evenly divided among participants. The individual's benefit is therefore the sum of their private resources and the return from the public account. What happens in this most basic setting, where institutional, social, and cultural context, social interactions, and domain-specific 'complications' are deliberately omitted? In such experiments, individuals initially contribute roughly 50 percent of their endowment to the public good[3], but after further experimental rounds, individuals contribute on average only about 10 percent of their endowment to the public good, with the majority of subjects not contributing at all (Fehr and Gächter 2000; Fehr and Schmidt 1999; Ostrom 2000). As Simpson and Willer (2015) argue, even these most unrealistic experiments can teach us a lot about cooperation in the real world:

> 'Although often criticized as artificial, experiments in which social context is deliberately minimized in fact tell us much about society. At the most basic level, the results of these studies in decontextualized settings tell us that something else is necessary, that high levels of cooperation cannot be sustained merely on the basis of the preferences and generalized trust that people carry around within them. Rather, the micro-level manifestations of social order — cooperation, trust, and prosocial behavior among individuals — require also the operation of mechanisms embedded in social settings. They are more than the direct products of individuals' altruism.'
> (Simpson and Willer 2015, p.45)

Recognising that 'something else is necessary', the literature has started to assess which building blocks can be added to the basic experimental setup to enable cooperation to be sustained over time. One of the major advances of this body of research has been the identification of several *social mechanisms* that can significantly slow or even halt the decay of cooperation. Among these are mechanisms of (indirect) reciprocity (Axelrod 1984; Gächter et al. 2017; Nowak and Sigmund 2005; Rand and Nowak 2013; Simpson et al. 2018), altruistically motivated sanctions or rewards (Andreoni et al. 2003; Fehr and Gächter 2000; Fehr and Gächter 2002; Fehr and Schurtenberger 2018), communication

[2]Here, we take the standard linear public goods game as the most basic scenario, which is discussed in more detail in section 1.3.

[3]With considerable variability across societies, demonstrating that individuals bring some of the social context to the laboratory (such as past experiences and internalised social norms) even when these are purposefully decontextualised (see e.g., Henrich et al. 2010; Levitt and List 2007).

between players (Balliet 2010; Ostrom 2000), and group formation (Brekke et al. 2011; Gächter and Thöni 2005; Guido et al. 2019; Gunnthorsdottir et al. 2007; Page et al. 2005). With the help of these mechanisms, cooperation may be stable over time. The clear benefit of these experiments is the ability to abstract from the messiness of the real world and systematically modify the setting to learn about factors that drive human cooperation and prosocial behaviour.

However, the real world *is* messy. Human decision making is much more complex than simple considerations about potential direct (monetary) costs and benefits of the individual actions, as people weigh moral and ethical considerations and are influenced by the social and biophysical context around them. At the same time, individuals in the real world are rarely put into a situation where they know that their choices will later be scrutinised by researchers, and they often do not even have to make a decision at all (Levitt and List 2007). Therefore, it is often unclear to what extent the results of these laboratory experiments will translate to cooperation and prosocial behaviour that we depend on in the real world (Baldassarri and Grossman 2013; Galizzi and Navarro-Martinez 2018; Levitt and List 2007; Stutzer et al. 2011).

In this thesis, I use blood donations as an ideal-typical example of cooperation and prosocial behaviour to study how these social mechanisms shape real world cooperation. As I will argue in more detail below, the system of blood donations in the Netherlands and Australia — the countries under study in this thesis — is an example of cooperation and prosocial behaviour that shares many of the features of basic experimental paradigms: there are no high-value incentives that compensate donors with the full social value of their contribution (Goette and Tripodi 2024; Graf, Oteng-Attakora, et al. 2023), they are anonymous and non-targeted such that donors cannot benefit their own kith or kin (Ferguson 2022; Ferguson and Lawrence 2016), and there is a widely used opportunity to free ride, with less than 10% of the eligible population donating at any one time (Abásolo and Tsuchiya 2014; Simonetti and Smit 2024). At the same time, the study of blood donation behaviour seems to have a 'missing context problem', in the sense that blood donations are typically seen as the product of individual altruism, without little consideration of the social context (Masser et al. 2020; Piersma et al. 2017). Only recently, building on early foundational work of Healy (2000), the literature has started to examine broader societal and social network influences on blood donation behaviour (Gorleer et al. 2020; Gorleer et al. 2023b; Graf, Suanet, et al. 2023; Masser et al. 2020).

The overall research question I will address in this dissertation reads: *How do social mechanisms shape repeated prosocial behaviour in the form of blood donations?*

In the remainder of the Introduction, I first discuss the societal and scientific relevance of blood donations in section 1.1. Section 1.2 briefly reviews the literature specifically on blood donation behaviour, and section 1.3 reviews the literature on how social interactions and social mechanisms can contribute to the sustained provision of public goods. Together,

these sections identify the gap in the literature that this thesis seeks to fill. Section 1.4 describes the contribution of this thesis and outlines each of the four empirical chapters and how they contribute to answering the overall research question.

## 1.1 Societal and scientific relevance of blood donation

Donations of whole blood, plasma and platelets, referred to as blood donations below, enable transfusions, many routine medical treatments (e.g., treatment of patients that suffered trauma or burn), and the production of plasma-derived medicinal products (Merz 2024; Slonim et al. 2014). Globally, the demand for blood and blood products is large and growing; Among others, this is due to a broadening range of therapies that rely on plasma-derived medicinal products, low collection rates in low- and middle-income countries, and ageing populations in high-income countries (Jaworski 2020; Merz 2024; Roberts et al. 2019; Simonetti and Smit 2024). For whole blood, Roberts et al. (2019, p. 606) estimate that 'every country in central, eastern, and western sub-Saharan Africa, Oceania, and south Asia had insufficient blood to meet their needs'. For plasma, the situation is even more grim, with estimates by Jaworski (2020) showing that only very few countries in the world, namely Austria, Czechia, Germany, Hungary, and the United States of America (USA), are able to meet their demand for plasma via domestic collection.

To meet this demand, a range of blood collection regimes have developed across the world. One dimension along which they vary is whether the blood collection is carried out by the state, the Red Cross, or multiple independent blood banks (Healy 2000; Slonim et al. 2014). Another important dimension is the extent to which donations are incentivised. Although only 0.2% of global whole blood donations come from paid donations according to the WHO (World Health Organization 2022), an estimated 90% of global plasma donations come from a few countries that allow paid donations, with the USA alone contributing about 70% to this supply (Jaworski 2020). Another distinction can be made between anonymous blood-banking systems where donors contribute to a common pool of available blood units, such as the ones in the countries under study in this thesis, and emergency and family replacement systems where blood comes from donors that are typically associated with recipients, such as family and friends (Slonim et al. 2014; World Health Organization 2017). Furthermore, these dimensions represent a spectrum rather than a dichotomous distinction. For example, there is a wide range of incentives with varying monetary value offered for blood and/or plasma donations in countries that largely follow a VNR donation system (Graf, Oteng-Attakora, et al. 2023; Koch et al. 2024), and some countries (e.g., Lebanon) use a system that is essentially a mix between a family replacement system and an anonymous and voluntary donation system (Haddad et al. 2019).

In this thesis, I study blood donation in the Netherlands and Australia. Both of these

countries follow the WHO guidelines on VNR donations (World Health Organization 2009). This means that there is no monetary compensation for whole blood, plasma, and platelet donations, and there are generally no high-value incentives for donations (Chell et al. 2018; Graf, Oteng-Attakora, et al. 2023). In addition, both Australia and the Netherlands have a monopoly system that is run by a non-profit organisation (NPO) acting as the national blood bank responsible for the collection of all blood donations within the country.

From a scientific perspective, voluntary and non-remunerated blood donations are an ideal-typical example of cooperation and prosocial behaviour. The terms cooperation and prosocial behaviour are often used interchangeably (Wittek and Bekkers 2015), and there is overlap in these constructs. Cooperation can be defined as a behaviour that benefits others and involves personal costs and potentially also personal gains (Ferguson 2022; West et al. 2007). Prosocial behaviour is often defined more narrowly, as a behaviour that benefits others at some personal cost (Wittek and Bekkers 2015). Prosocial behaviour is therefore typically defined as a behaviour that (exclusively) benefits one or more others, while cooperation is often defined as a behaviour that benefits a group, potentially including the self. In VNR systems, blood donation is voluntary, personally costly in terms of time and potential inconvenience (e.g., stress (Hoogerwerf et al. 2018)), and generally benefits unknown others — all of which are textbook characteristics of prosocial behaviour. Direct benefits from blood donation are small, since own donations should only marginally increase the availability of blood and blood products that a donor or their family and friends might depend on at some point in their life. However, there may be indirect benefits in the form of small incentives (e.g., cookies or small gits), reputational gains, or feelings of warm glow (Andreoni 1989; Ferguson 2022). Clearly, cooperation and prosocial behaviour intersect: donors cooperate by contributing to a public good that provides benefits to all, and their actions are inherently prosocial. In previous literature, blood donation is more frequently discussed as prosocial behaviour, likely reflecting the assumption that the personal costs of donation largely outweigh the (direct) personal gains, rendering blood donation an altruistic behaviour (Ferguson 2015). Throughout the thesis, I follow the literature by generally referring to blood donation as a prosocial behaviour. However, I sometimes also use the term cooperation, in particular when discussing studies using the public goods game, since this game is generally understood as a game that captures cooperation rather than prosocial behaviour (Levitt and List 2007).

The anonymity for both donor and recipient also sets blood donations apart from other forms of real-world prosocial behaviour, such as charitable giving and volunteering, which can more directly benefit the donor's in group or even donors themselves (Barman 2017; Havens et al. 2006). Since prosocial behaviour is usually stronger towards in-group members (Balliet et al. 2014; Leider et al. 2009), the anonymity of blood donation makes it a particularly interesting form of prosocial behaviour from the perspective of theoretical models in Evolutionary Biology and Economics that assume fitness or utility maximisation

(Boyd et al. 2003; Gintis 2003; Henrich et al. 2001; Nowak 2006; Ohtsuki et al. 2009; Rand and Nowak 2013). Because of these characteristics, studying blood donations can help us to better understand sustained and high-cost cooperation and prosocial behaviour (Ferguson 2022).

## 1.2 The literature on blood donation behaviour: A selective review of reviews

The literature on blood donation behaviour is far too broad to review in its entirety for the purposes of this thesis. In what follows, I synthesise insights from several in-depth reviews of the literature to provide a high-level introduction to the field of research on blood donation behaviour, and identify the gap in the literature that this thesis seeks to fill. A common finding across multiple of these reviews is that the blood donation literature has a 'missing social context problem', meaning that there is very little knowledge on how the social context and social networks affect blood donation behaviour.

### 1.2.1 Established findings: correlates of blood donation behaviour, self-reported motivations and barriers

When openly asked why someone donates blood, the most common self-reported motivations are altruism, warm glow, social influences, advertisements, and selfish motivations such as finding out about one's blood type (Bednall and Bove 2011; Burzynski et al. 2016; Ferguson et al. 2020; Huis in 't Veld et al. 2019; Lownik et al. 2012; Romero-Domínguez et al. 2019). Among the most common self-reported barriers for blood donation are health concerns, not having been asked, fears associated with the donation process, low self-efficacy in donating, a general lack of knowledge about donating, and negative service experiences (Bednall and Bove 2011; Burzynski et al. 2016; Ramondt et al. 2020).

Several reviews paint a relatively clear and coherent picture of individual-level predictors of blood donation behaviour, with a particular focus on individual-level motivations and barriers elicited via surveys (Bednall et al. 2013; Berger et al. 2023; Ferguson 1996; Masser et al. 2008). Bednall et al. (2013) conducted an extensive review and meta-analysis covering the literature focused on predicting blood donation behaviour. They identified the Theory of Planned Behaviour (TPB) (Ajzen 1991; Masser et al. 2020) as the dominant theoretical paradigm for the study of blood donation behaviour. The TPB applied to blood donation states that Blood donation behaviour is primarily determined by the intention to donate, which is in turn affected by attitude (positive or negative evaluation of the behaviour), subjective norms (perception of social pressure), and perceived behavioural control (PBC, the perceived ease of performing the behaviour), which is also proposed to

directly affect behaviour (Ferguson 1996; France et al. 2007). The concept of PBC is often understood to be synonymous with Bandura's concept of self-efficacy (the perceived capacity to perform a behaviour), which has been found to be the stronger predictor of intentions and behaviour when compared to PBC (Bednall et al. 2013; Giles et al. 2004). The TPB is often at the core of empirical studies of blood donation behaviour, and numerous extensions have been proposed to the TPB to increase its explanatory power with regards to blood donation behaviour (e.g., France et al. 2007; Masser et al. 2009), and several additional individual-level factors have been shown to be correlated with blood donation behaviour: prosocial motivations, affective expectations, collection centre experiences, and socio-demographic characteristics (Bednall et al. 2013; Piersma et al. 2017). Among the strongest positive predictors of donation behaviour are a stated intention to donate, self-efficacy, anticipated regret for not donating, age, and the past number of donations. The strongest negative predictors are deferral and adverse reactions.

Knowledge about strategies to successfully promote blood donations is much less consolidated. According to reviews of potential strategies to promote blood donation, effective strategies among the ones studied are appeals to motivations (altruism, social norms, and attitudes), and simple reminders and solicitations, for example through letters and phone calls, although both strategies also show a high variability in effect sizes (Godin et al. 2012; Irving et al. 2020). The most commonly used but also contested type of strategy to promote blood donation are incentives. Although the use of high-value incentives, such as cash payments, gift cards, or time off work, is widespread (Graf, Oteng-Attakora, et al. 2023; Koch et al. 2024), their effectiveness is still debated in the literature (Bruers 2022; Chell et al. 2018; Gneezy 2023; Goette et al. 2010; Irving et al. 2020; Lacetera et al. 2013; Niza et al. 2013) and likely depends on the societal context where they are implemented (Graf, Suanet, et al. 2023).

### 1.2.2 The influence of social context and social interactions on blood donation behaviour

In recent years, several reviews have pointed out two limitations that are common to much of the research on blood donation behaviour: a lack of considerations about the social context of blood donation behaviour, and the limited potential of deriving effective strategies for promoting blood donations from the prevailing descriptive theories of blood donor behaviour (Berger et al. 2023; Masser et al. 2020; Piersma et al. 2017).

For example, in an interdisciplinary review of individual, social network, and contextual characteristics of donors and non-donors, Piersma et al. (2017) found few studies that even consider how contextual factors such as urbanisation and population composition affect blood donation behaviour, and found no study on social network characteristics of (non) donors. Similarly, Masser et al. (2020, p. 175) argue that the field 'has typically drawn on a

homogeneous set of descriptive theories, viewing the decision to become and remain a donor as the outcome of affectively cold, planned, and rational decision-making by the individual', which has not 'translated into a suite of effective interventions'. Accordingly, they call for more research into contextual factors, and approaches that lead to applicable knowledge for blood banking practice. Finally, a recent review of factors that influence plasma donation Berger et al. (2023) finds that 'further research must examine what factors attract non-whole blood donors to become plasma donors, focusing on broader social-level influences'.

The limited attention to social context and social mechanisms in research on blood donation behaviour does certainly not mean that no work at all has been done in this area. On a high level, foundational work by Healy (2000) and Healy (2006) argued that collection regimes themselves produce the composition and characteristics of a countries donor population by providing differing opportunities for donations, a line of research recently extended by Gorleer and colleagues (Gorleer et al. 2020; Gorleer et al. 2023a; Gorleer et al. 2023b). Related to this line of research is the work on incentives and healthcare systems across societies (Chell et al. 2018; Graf, Oteng-Attakora, et al. 2023; Graf, Suanet, et al. 2023).

Recent work has also started to examine how smaller scale contextual-level differences might affect donation behaviour. One important contextual level for blood donation behaviour is the collection site, and it has been shown that collection site characteristics, such as opening hours and perceived service quality, and the opening and closing of collection sites influence donation behaviour (Merz et al. 2017; Piersma et al. 2021).

On the level of social networks, previous studies have shown that donors are often recruited by other donors (Bani and Strepparava 2011; Misje et al. 2005; Oborne and Bradley 1975; Piersma and Klinkenberg 2018). Recent work by Ciausescu et al. (2023) has shown that there is intergenerational transmission of blood donation between parents and their children, which is partly explained by the strength of the parents' donor identity and donation activity.

Ferguson (2015) and Ferguson and Lawrence (2016) provide important reviews focused on theory building, which integrate the blood donation specific literature into the broader literature on cooperation and prosocial behaviour from evolutionary biology, economics, and psychology. One of their contributions is to show how the social mechanisms discussed in the broader literature might lead to the descriptive patterns of donor characteristics often described in the blood donation literature (e.g. reputation regulation might be the mechanism underlying the formation of subjective norms). In developing the 'mechanisms of altruism' approach, Ferguson and Lawrence (2016) also make an explicit connection between the blood donation literature and the literature on social interactive mechanisms that promote cooperation, such as reciprocity and conditional cooperation, and discuss their potential implications for the case of VNR blood donations.

Recently, several studies have started to empirically evaluate how social mechanisms might be used to promote blood donation. Sun et al. (2019) show that, if properly incentivised, asking donors to recruit within their social networks can be a successful and cost-effective strategy. Bruhin et al. (2020) show that invitations to donate that are sent to donors living together with another donor are much more effective than invitations sent to donors that live alone. Recently, Goette and Tripodi (2024) have shown that the application of social mechanisms to blood donation can also backfire: interventions that offer social recognition on social media to blood donors in Italy were at best ineffective in increasing the donation rate and in some cases even resulted in lower donation rates when compared to a simple solicitation for a donation. A potential explanation is that 'recognition backfires when good actions do little to improve altruistic image and instead signal image concern' (Goette and Tripodi 2024, p. 4).

## 1.3 What can laboratory experiments on cooperation teach us about the impact of social mechanisms on blood donation?

In contrast to the blood donation specific literature, there is a large body of experimental literature that has tried to identify the contextual conditions and social interactive mechanisms that allow cooperative behaviour to thrive. A standard experimental scenario to study cooperation is the public goods game (PGG) (Kudo et al. 2024; Ledyard 1995)[4]. The standard linear PGG is played in groups of more than two players (often four), and each individual is given some initial endowment (dollars, tokens). Next, individuals privately choose how much of their resources to contribute to a public account. The resources in the public account are multiplied by a factor larger than one, and the resources from the public account are then evenly divided among participants. The individual's benefit is therefore the sum of their private resources and the return from the public account. By definition, a public good is non-excludable, which means all may benefit from it regardless of whether they contributed to it (Kollock 1998). These features also result in two well-known properties characterising a social dilemma: '(a) the social payoff to each individual for defecting behavior is higher than the payoff for cooperative behavior, regardless of what the other society members do, yet (b) all individuals in the society receive a lower payoff if all defect than if all cooperate' (Dawes 1980, p. 170).

[4]The same game is sometimes called the voluntary contribution mechanism (VCM) (Gächter 2007; Gunnthorsdottir et al. 2007).

### 1.3.1 Social mechanisms sustaining cooperation in the public goods game

From PGG experiments, there is a lot of evidence that prosocial behaviour deteriorates over time if individuals act in 'social vacuum', i.e., when social context and relations are precluded from affecting individuals' behaviour (Chaudhuri 2011; Rand and Nowak 2013; Simpson and Willer 2015). For example, this is the case in repeated PGGs without interactions between subjects. The results of these studies, where social context is deliberately minimised, illustrate that the persistent prosocial behaviour we observe in numerous areas in the real world is based on social mechanisms embedded in social contexts (Simpson and Willer 2015).

A large body of literature has identified such mechanisms. Extensively studied mechanisms include direct reciprocity, communication, rewards, punishment, conditional cooperation, reputation formation, and group formation (Balliet et al. 2011; Gross et al. 2023; Rockenbach and Milinski 2006; Simpson and Willer 2015). However, not all of these mechanisms will play an equally important role in current VNR blood donation systems, and they are not equally well suited to be implemented as strategies by blood banks (Ferguson 2015; Ferguson and Lawrence 2016). Given the similarities and differences between the PGG and the VNR blood donation system, what can we learn from the social mechanisms in PGGs that are relevant for understanding social mechanisms in the VNR blood donation system? The characteristic of anonymity means that we can already conclude that direct reciprocity (Nowak 2006) and kin-selection, such as giving of blood (only) to kith and kin (Rand and Nowak 2013), will not be social mechanisms at work in this context. Further, the anonymity and universal distribution of blood/and plasma donations (in the case of whole blood within national borders) means that other relationships between donors and recipients should not play a role. Therefore, further processes of 'selective prosociality' (Keltner et al. 2014, p. 433) taking shape in dyadic relationships, such as self-other similarity and strategic prosocial behaviour towards other prosocially engaged individuals, should not play a role in the context of blood donations.

Below, I briefly review conditional cooperation, communication, and group formation as social mechanisms that have been identified as important in PGG experiments and that can be at work in VNR blood donation systems.

**Conditional cooperation:** A long line of research has established that a substantial proportion of participants in PGGs behave in a conditionally cooperative way (Chaudhuri 2011; Fischbacher et al. 2001; Ones and Putterman 2007; Thöni and Volk 2018). That is, they tend to contribute to the public good if they think that others contribute as well. Across several studies, about 60 percent of people could be classified as conditional coop-

erators (Thöni and Volk 2018)[5]. The mechanism of conditional cooperation itself is not necessarily beneficial for achieving high rates of blood donation. In many countries, only a small fraction of the population donate blood at one point in time. In these situations, conditional cooperators would therefore also be unlikely to cooperate. In addition, many subjects in PGGs behave as imperfect conditional cooperators, meaning that they tend to give a little less than they perceive others to give (Ferguson and Lawrence 2016; Fischbacher and Gächter 2010). An important question is therefore whether and how conditional cooperation is at work in blood donation, and whether it can be used to increase blood donation. For example, the common strategy to portray blood donors as rare 'altruistic unicorns' might backfire if received by a conditional cooperator because it signals that most people do not donate blood (Ferguson and Lawrence 2016; Healy 2000).

**Communication:** Communication among participants before or during the game has long been recognised as a tool for improving cooperation rates in the PGG (Balliet 2010; Dawes 1980; Kudo et al. 2024; Zelmer 2003). There are several explanations for why this might be the case: communication might lead to an increased perception of similarity between self and other, provide commitment, the formation of a group identity, and make norms more salient (Balliet 2010; Dawes 1980). In the real world, the default is of course that (potential) donors can freely communicate with each other. However, there are differences in the extent to which individuals communicate about blood donation specifically, and increasing blood-donation-specific communication might therefore be a successful strategy for increasing donations.

**Group formation:** Another growing strand of the literature has identified the formation of groups among contributors as a strategy to increase the overall level of contributions to a public good (Chaudhuri 2011; Guido et al. 2019; Kollock 1998). It departs from the key insight discussed above that a substantial proportion of people are conditional cooperators. Building on this insight, several laboratory experiments have shown that high levels of cooperation can be maintained when (potential) contributors are either sorted or self-selected into groups based on past contributions (Guido et al. 2019). For example, Gächter and Thöni (2005) conducted an experiment where participants are first ranked by their contribution in a one-shot PGG, and subsequently participate in a repeated PGG where the formation of the group is either random or based on the participants' 'prosociality-rank' assigned in the prior one-shot PGG. Over time, contributions in sorted groups remain much higher than in random groups. Gunnthorsdottir et al. (2007) replicated this finding and showed that the reason for this pattern evolving over time is that people that are a-priori

[5]Ferguson and Lawrence (2016) and Ferguson et al. (2012) have additionally identified the inverse pattern of conditional cooperation as a motivation underlying blood donation behaviour, namely reluctant altruism. In contrast to conditional cooperators, reluctant altruists contribute at higher rates when overall contributions are low, exactly because they do not trust others to contribute at sufficient levels.

classified as cooperators continue to contribute in sorted groups, whereas they reduce their contributions in random groups. In comparison to randomly matched groups, contributions in the sorted groups are always higher and decay slower over time.

### 1.3.2 The external validity of social preference games

Laboratory experiments on cooperation and prosocial behaviour make the critical assumption that insights gained in the laboratory can be extrapolated to the real world, a principle known as generalisability or external validity (Levitt and List 2007).

In laboratory experiments, we can try to isolate individuals' decision making when only taking into account considerations about the direct monetary costs and benefits of the individual actions. Outside of the laboratory, however, human behaviour is also affected by many other things, such as moral and ethical considerations, the evaluation of one's behaviour by others, and the social and biophysical context Levitt and List (2007). At the same time, the decision-making process might be less deliberate than is implicitly assumed in experimental studies, since individuals are not put into a situation where they know that their choices will later be scrutinised by researchers. Furthermore, experiments put strong artificial restrictions on the choice sets. For example, individuals in public goods gamed are forced to either contribute or not (or to drop out of the experiment), while people in the real world have often a basically unlimited set of choices, and they might even take action to avoid having to make a decision (Andreoni et al. 2017). In addition, many (especially earlier) experimental studies were conducted in student populations in WEIRD (western, educated, industrialised, rich, and democratic) countries, and it has been shown that these are not generally representative of human behaviour (Henrich et al. 2010).

The systematic literature review by Galizzi and Navarro-Martinez (2018) shows that the correlation between outcomes in social preferences games and outcomes observed in the real world is 0.14, providing only weak evidence that social preference games are reflective of real-world prosocial behaviour. In addition, Galizzi and Navarro-Martinez (2018) have shown that in a student sample, behaviour in the public goods game also weakly correlates at 0.14 with the previously elicited self-report altruism scale (Rushton et al. 1981), and neither positively nor negatively with prosocial behaviour (e.g., helping behaviour and charitable giving) after playing the experimental games. Using only the question related to blood donation, 'I have donated blood.', with responses ranging from 'never' (1) to very often (5), the correlation between contributions in the PGG and blood donation behaviour is -0.06 ($p = 0.300$)[6], also indicating low overlap between decisions in the PGG and decisions about blood donation behaviour. However, the sample used in this study was a convenience sample, again limiting the generalisability of these findings to a broader (non-student) population. A recent study by Wang and Navarro-Martinez (2023) shows that the

[6]Thanks to the authors for making their data publicly available.

external validity of these social preference games can be increased by reducing measurement error through collecting multiple measures and applying statistical techniques that account for measurement error. They show that 'as more pro-social behaviors and game rounds are aggregated, the games become much better predictors of pro-sociality' (Wang and Navarro-Martinez 2023, p. 261).

In summary, the literature comparing individuals' behaviour in a single social preference game to their real-world prosocial behaviour at one specific opportunity seems to provide limited evidence for a correlation between the two, which can be improved by observing both behaviour in games and in the real world for a longer time period. However, we are less interested in the overlap between the behaviour of individuals in the lab in the field, but more interested in whether the *patterns* observed in numerous experimental studies will translate to the field. This question seems to have received limited attention so far. In addition, it can hardly be answered in general, but requires specific attention and analysis of the behaviour and context that we are interested in.

### 1.3.3 VNR monopoly blood collection and public goods games: how similar, how different?

What can we learn from the insights generated using the PGG? How closely do public goods experiments resemble the VNR blood donation context?

Like in the PGG, blood donations in the Netherlands and Australia represent contributions to a public good in the form of the national and global supply with blood and blood products. Representing a crucial characteristic of prosocial behaviour and cooperation, there are no high-value incentives that compensate donors with the full social value of their contribution, and, because blood donations are anonymous and non-targeted, donors cannot benefit their own kith or kin (Lyle et al. 2009; Rand and Nowak 2013). In addition, these systems provide an opportunity to free ride: it is not necessary to be a blood donor to benefit from a transfusion or receiving plasma-derived medicinal products (Abásolo and Tsuchiya 2014). This opportunity is also widely used: In European countries, between 50 to 80 percent of people have never donated blood (Graf, Suanet, et al. 2023), and less than 10% of the eligible population donate at any one time (Abásolo and Tsuchiya 2014; Simonetti and Smit 2024).

Another important difference between the PGG and VNR blood donation is the scale of the social dilemma, including the number of participants involved. In a PGG, group size is typically small, ranging from just two to about 10 participants (Pereda et al. 2019; Zelmer 2003). In such small groups, the individual payoff will be much more easily swayed by an individual's strategic actions. For example, a highly successful strategy for cooperation is tit for tat, meaning that an individual reciprocates the actions of the partner(s) (Axelrod 1984). This strategy might increase the individual payoff, because other players

will understand that their payoff will also be higher when they contribute as well. Through strategic behaviour, an individual can therefore have a significant impact on their own payoff. However, with several million people involved, the individual's decision about whether to cooperate or not has negligible impact on their own and others benefit (Pereda et al. 2019), i.e., the probability of receiving a transfusion or a blood product in the future.

Both in VNR blood donation and PGGs, individuals make repeated decisions about whether to contribute or not. In the PGG, however, the participants of the game are immediately informed about their payoff, which provides much more immediate feedback about the other players level of cooperation and is much more salient and immediate than the outcome of donating blood. Providing information about the outcome of donating blood, however, seems to be an effective strategy for increasing donation rates (Shehu et al. 2023).

## 1.4 Contribution of this thesis

The main contribution of this thesis is to conceptually and empirically link the individual-centred blood donation literature with the experimental literature on social mechanisms that sustain cooperation. At the core of the experimental studies reviewed above is the analysis of how interacting choices of individuals produce aggregate outcomes. In contrast, the blood donation specific literature focusses mainly on individuals and their decision-making process about blood donation. By integrating these two lines of research, I tackle limitations in each of them: the limited attention to social interactive mechanisms in the empirical literature on blood donation behaviour, and the little attention to the individual decision-making process and limited external validity of laboratory experiments on cooperation.

To integrate the insights from these two strands of the literature, I make use of the Modelling Human Behaviour (MoHuB) framework (Schlüter et al. 2017). The MoHuB framework extends models of social-ecological systems with elements that capture human decision making. The core characteristic of the social-ecological systems perspective is that individuals are influenced by the social and physical environment that they are embedded in, and that this environment simultaneously emerges from the choices of individuals (McGinnis and Ostrom 2014; Schlüter et al. 2017). At the same time, the social-ecological systems perspective regards individuals as autonomous agents that make decisions based on their characteristics, beliefs, and attitudes. Because of this integration of perspectives, the MoHub framework is particularly useful for understanding human decision making in social context.

The MoHuB framework does not predetermine the use of a specific theory of human behaviour. Instead, it provides a framework consisting of central building blocks that can be used to comparing and contrasting theories of human behaviour in social context. These

building blocks are the individual's *state* and *perceived behavioural options*, and the individual's decision-making process, which is captured by the four processes of *perception*, *evaluation*, *selection of behaviour,* and *behaviour*. These elements are defined in Table 1.1.

Figure 1.1 shows my conceptual model of blood donation behaviour in social context. The individual (black circle) is embedded in a social network (purple curve), and within a broader social and biophysical environment (turquoise curve). The decision-making process starts with an individual's perception of their social and physical environment. The individual then evaluates new information and potentially updates their state based on these inputs. The individual's state affects the perceived behavioural options. The state and the perceived behavioural options feed into the process of selecting a behaviour. Finally, a behaviour is executed and affects social networks and the social and biophysical context.

**Table 1.1** Elements of the MoHuB framework based on Schlüter et al. (2017, p. 25).

| **Element** | **Definition** |
|---|---|
| State | 'The internal state of an individual. It includes attributes of an individual that influence the behaviour selection process and possibly the perceived behavioural options. There are four classes of attributes: needs/goals, knowledge, assets, values.' |
| Perceived behavioural options | 'The set of options the individual perceives and thus can choose from.' |
| Perception | 'The process by which an individual senses the surrounding social and biophysical environment.' |
| Evaluation | 'The process by which an individual determines the significance, worth, or condition of the perceived state of the social and bio-physical environment.' |
| Selection | 'The process by which an individual chooses her behaviour from the set of perceived behavioural options taking its state into account, resulting in the executed behaviour.' |
| Behaviour | 'The behaviour that an individual executes as a result of the decision-making process.' |

The main contribution of the experimental literature on cooperation to my conceptual framework is the emphasis on the social interactive mechanisms operating at the meso level, i.e. within social networks and through social relations. In this thesis, I specifically examine the mechanisms of conditional cooperation, communication, and group formation. The main contribution of the individual-centred literature on blood donation behaviour to the conceptual framework is the richer understanding of the individual decision-making

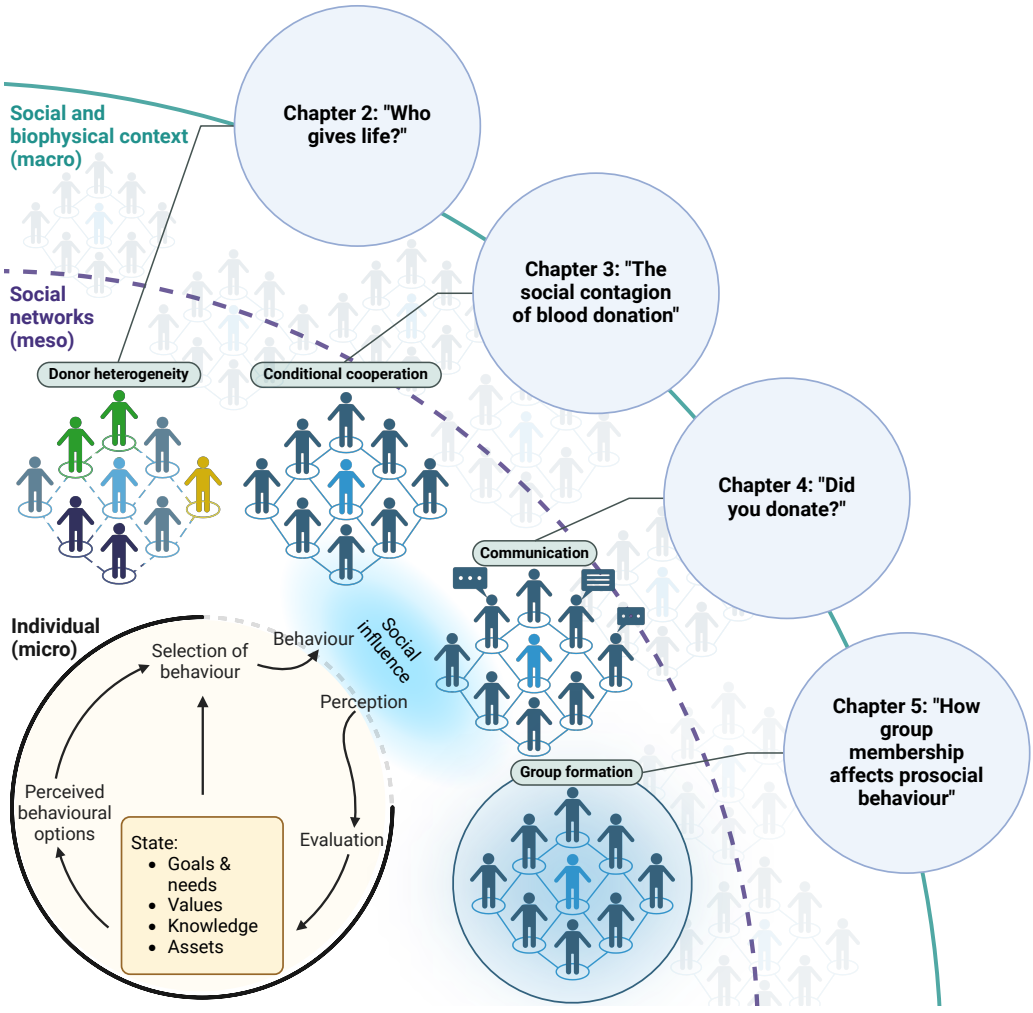


**Figure 1.1** Social-ecological systems model of blood donation behaviour underlying this thesis. Notes: The individual (black circle) is embedded in a social network (purple curve), and within a broader social and biophysical environment (turquoise curve). The decision-making process is depicted on the individual (micro) level. Motivational heterogeneity among donors and the three social mechanisms of social contagion, communication, and group formation are depicted on the meso level.

process. Underlying many studies conducting social preference games such as the public goods game is the rational choice framework, where individuals are exclusively self-interested, possesses perfect knowledge of the world and unlimited cognitive capacity, maximise utility, and are fully aware of future costs and benefits of their actions (Camerer and Fehr 2006; Ostrom 1998; Schlüter et al. 2017; Simon 1978). There is value in parsimonious theoretical models for understanding behaviour (Healy 2017; Smaldino 2017). However,

several of the assumptions of rational choice theory may be overly reductive, especially when moving from a laboratory to a field context (Van Lange et al. 2007). For example, in the small worlds that laboratory settings generate, the assumption of perfect information about others' behaviour might not be unreasonable. In the real world, however, the ability to perceive information is bounded by the structure of the social and physical environment (social networks, geographical boundaries), and cognitive constraints such as a limited memory of others' beliefs and behaviour (Conlisk 1996; Schlüter et al. 2017; Simon 1955).

The large body of individual-centred literature on blood donation behaviour can help to gain a better understanding of both *how* social interactions may affect blood donation, and an understanding of where the real world may or may not follow predictions derived from game-theoretical models and laboratory experiments. Throughout the dissertation, I draw on multiple individual-centred theories of blood donation behaviour, but do not generally conduct the analyses within a specific theoretical framework. The TPB, as one of the most widely used theoretical models for studying blood donation behaviour (Ferguson et al. 2007; Masser et al. 2020), is one of the theoretical corner stones of three empirical chapters in this dissertation. Chapter 2 specifically draws on an extension of the TPB developed to model repeated blood donation behaviour. Chapters 3, 4, and 5 are interested in specific relationships between concepts of interest and blood donation behaviour, and we therefore draw on the numerous constructs developed in the empirical blood donation literature to account for potential confounders of the relationship that I am interested in. An important differentiation from the TPB throughout the thesis is the omission of behavioural intentions as the outcome variable of interest or as the only construct determining donation behaviour. Several contributions have shown that the predictive power of blood donation intentions for behaviour is relatively low (Bednall et al. 2013; Godin et al. 2005), and I am ultimately interested in blood donation behaviour rather than intentions. Furthermore, drawing on blood bank register data throughout the thesis allows us to directly assess the determinants of behaviour as opposed to intentions.

In summary, this thesis contributes to the literature by generating and answering questions in the field of cooperation and blood donation by using an innovative interdisciplinary approach that combines insights from different theoretical backgrounds and research traditions (experimental, observational, theoretical), focussing especially on the meso-level context of social interactive mechanisms. As highlighted by Ferguson (2015, p. 211), the approach we chose to understanding blood donation comes 'with enormous implications for the type of interventions we choose to adopt as a society'. In its focus on social interactive mechanisms, this thesis pushes the field to move towards a more strategic perspective of blood collection systems, more collaboration and cross-pollination between basic research on cooperation and applied blood donation literature, and by producing insights that are of relevance to both our understanding of prosocial behaviour and blood banking practice.

### 1.4.1 Thesis outline

An overview of the chapters of the dissertation is given by Figure 1.1. Below, I briefly describe each of the chapters and their contributions to research and practice.

**Chapter 2: 'Who gives life?'** Chapter 2 tackles the question whether there are distinct motivational types of donors in the Dutch blood donor population, how transition paths between donor types over time look like, and to what extent belonging to one of these types is associated with long-term donor lapse. Donor retention poses a major challenge for blood collection agencies because many donors lapse after having made only few donations. Previous literature has identified a broad range of individual-level factors that explain donor retention. However, donors in these studies are typically treated as a homogeneous group. This limits both our theoretical understanding of donor behaviour and the effectiveness of interventions aimed at donor retention. In Chapter 2, I therefore aim to identify donor types based on constructs from an extended TPB, prosocial values, and social network characteristics, which have been identified as central drivers of repeated blood donation behaviour. I apply latent profile analysis and latent transition analysis to a large sample of blood and plasma donors in the Netherlands (N = 22128), and identify four types of donors that very in their motivations for giving blood, their sociodemographic composition, and their long-term donor lapse: the exceptionally motivated donors (18%, high motivation across constructs, 42% lapse), the unfulfilled donors (23%, low motivation across constructs, 62% lapse), the balanced donors (33%, average motivation across constructs, 45% lapse), and the confident habitual donors (26%, high on self-efficacy and habit formation, average on other constructs, 40% lapse). I discuss the implications of the typology for theories of repeat blood donation and strategies aimed at donor retention. As the first empirical chapter of this thesis, Chapter 2 also provides a synthesis of prior literature on repeated blood donation behaviour. In doing so, it also shows the lack of research into social influences on repeated blood donation behaviour.

**Chapter 3: 'The social contagion of blood donation'** In Chapter 3, I set out to test the mechanisms of conditional cooperation/social contagion in the real-world prosocial behaviour of blood donation, and to identify whether it is explained by normative and informational social influence. More specifically, I examined to what extent social contagion within neighbourhoods – changing behaviour in response to the behaviour of others – affects repeated blood donation behaviour. In addition, I analysed whether this effect is mediated by motivations and attitudes of blood donors, including subjective norms, self-identity, moral norms, awareness of need, and cognitive attitudes. I draw on longitudinal survey and register data from a representative sample of blood donors in the Netherlands from 2007 to 2014 (N = 15090). Using a panel data model and an instrumental variable

approach, I find that donors are positively affected by donations made by other donors living in their neighbourhood. Exploratory analysis further attributes this finding to social contagion within donor couples. However, I did not find evidence that this effect is mediated by normative or informational social influence. Chapter 3 therefore shows that the mechanism of conditional cooperation is at work in the real-world prosocial behaviour of blood donation. On average, blood donations by individuals and others complement rather than substitute one another. In addition, I do not find evidence that the effect of social contagion is mediated by attitudinal constructs included in current theoretical models of repeated blood donation behaviour.

**Chapter 4: 'Did you donate?'** Chapter 4 assesses the social mechanism of communication between donors and assesses its relevance from an organisational perspective. It tackles the question whether talking about donations and being recruited via word of mouth (WOM) predicts donors' compliance with solicitations for blood donations. Chapter 4 departs from the insight that many forms of prosocial behaviour, including blood donation, are highly institutionalised: they are facilitated by organisations that broker between donors and recipients. A highly effective tool that organisations use to elicit prosocial behaviour are solicitations for donations (e.g., of blood, time, or money). In Chapter 4, I use register and survey data on blood donations in the Netherlands (N = 157017 solicitations) to examine to what extent compliance with these solicitations is predicted by being recruited via WOM and talking about donations. I find that donors that are one unit higher on the measure of talking about donations (range = 1-4) have a 2.9 percentage points higher compliance with solicitations for donations. In addition, this association is stronger for novice donors. This study demonstrates the social embedding of the donors' decision-making processes about compliance. For practice, the results imply that organisations may increase their contributors' communication about donations to increase the effectiveness of their solicitations.

**Chapter 5: 'How group formation affects blood donation behaviour'** In Chapter 5, I evaluate whether an intervention set up to make use of social mechanisms such as conditional cooperation and communication — a nationwide group membership programme among blood donors in Australia — is effective for increasing the participants donation frequency. Numerous experimental studies using the PGG suggest that contributions can be increased by the formation of groups among those that are active contributors. In Chapter 5, I study whether this mechanism generalises to high-cost contributions to the public good of the blood supply. I analyse a nationwide group donation programme in Australia, which enables blood donors to form groups with other donors, often around pre-existing social ties at the workplace, educational institution, or among neighbours, family, or friends. Using a difference-in-differences design, I show that joining a blood donor group increases

donation frequency by about 37%, and that the positive effect remains for about two years. Furthermore, the results show that joining a more active group increases donation frequency more strongly than joining a less active group, which is in line with the explanation that conditional cooperation is in part responsible for the effectiveness of group membership. Chapter 5 shows that blood banks can successfully make use of mechanisms such as conditional cooperation and communication among donors to increase the donation frequency of existing donors. In addition, I contribute to the literature on institutional design for promoting prosocial behaviour by showing that the strategy of group formation among contributors works in the real world, at societal scale, and even for the high-cost prosocial behaviour of blood donations.

**Chapter 6: General discussion** Chapter 6 provides a summary and critical evaluation of the research that has been done in the empirical chapters. It focuses on the implications for research and practice. In addition, I discuss current challenges in collaborations between researchers and blood banking practitioners, and how to potentially tackle these challenges to achieve mutual learning. Finally, it highlights areas for future research that emerge from the research conducted in this thesis.

## 1.5 Data sources and methods used

Throughout the empirical chapters of this thesis, I have drawn on a combination of survey and register data and applied a broad range of statistical methods in their analysis.

The main type of data used in all chapters is routinely collected register data by the blood collection organisations Sanquin (in the Netherlands) and the Australian Red Cross Lifeblood (in Australia). In this thesis, I analyse data on millions of donations made by tens of thousands of donors across these two countries. Major benefits of using register data are that it covers the complete population of donors in each of these countries, which avoids problems of sampling bias. In addition, the use of register data allows us to analyse actual donation behaviour thus avoiding self-reporting or recall-bias, and longer time periods than what is typically covered in surveys.

Another important data source for this dissertation is the Donor InSight (DIS) study, which is a large survey conducted among blood donors in the Netherlands (Timmer et al. 2019). The first two waves of the survey were conducted in 2007-2009 and in 2012-2013 with over 30000 participants each and over 20000 donors that participated in both waves of the survey.

Another strength of this thesis lies in the linkage of these two types of data. In several chapters, I have made use of a combination of these register and large-scale survey data. By combining these two types of data, I avoid recall bias and social desirability bias with

regards to outcomes, but we can still learn about the individual decision-making process by analysing individuals' perceptions and attitudes.

Throughout the empirical chapters of this thesis, I apply a broad range of statistical techniques to analyse these data sets, including factor analysis, linear and non-linear regression, structural equation modelling, mixture modelling, and frequentist and Bayesian multilevel modelling.

A challenge that occurs when translating research from the laboratory to the real world is that we usually need to trade in some degree of confidence in causality for increased external validity. To be able to identify causal effects in real world behaviour, I have made use of the rich toolkit of applied microeconomics for recovering causal effects from observational data (e.g., instrumental variable estimation, random and fixed effects panel data models, (synthetic) differences-in-differences). Combining different types of data and methods contributes to increased depth, rigour, and applicability of my research.

## 1.6 Positionality statement

This thesis follows a post-positivist ontology, assuming that there are some facts about the real world that we can try to learn about, but that our theories, assumptions, hypotheses, knowledge, and values affect our decisions about what to study, how to conduct research, and how to interpret results (Robson 2016). Choices in the process of data analysis were made deliberately and are documented in the empirical chapters and their preregistrations. The existence of this 'garden of forking paths' (Gelman and Loken 2013, p. 1) during data analysis has long been recognised within the open science movement (Engzell and Rohrer 2021; Gelman and Loken 2013). However, this 'garden of forking paths' exists throughout the whole research process, from selection a research question, to selecting a sample, data collection strategy, operationalisation of measures, data analysis, and interpretation, and these might have been influenced by my own position as a researcher in relation to the research topic (Engzell and Rohrer 2021; Gelman and Loken 2013; Jamieson et al. 2023).

A strong influence on the direction of the research conducted in this thesis is the work done by others within the DONORS ERC project that funded my PhD, and the work conducted at the Dutch blood bank Sanquin before my arrival. For example, the existence of the DIS data set and certain assumptions that come with this data set have shaped the analyses that I decided to conduct.

An assumption that is important for the conclusions and policy recommendations of some empirical chapters is that sufficient regulations are in place that safeguard the health of our donors. This is important in light of the goal of many blood banks to increase the donation frequency and length of the donor career of existing donors. However, high-

frequency blood donation may have negative health consequences, and improved donor retention might therefore cause harm to some people, if appropriate regulations are not in place. The topic of appropriate regulations such as those regarding donation frequency, however, is an active field of research (Sweegers et al. 2020; Van Remoortel et al. 2023).

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# Chapter 2

# Who gives life? Understanding blood and plasma donor types in the Netherlands

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## Abstract

Blood donations are essential for many routine medical procedures and the development of plasma-derived medicinal products. Donor retention poses a major challenge for blood collection, because many donors lapse after having made only few donations. In previous research, blood donors are typically treated as a homogeneous group, which limits both our theoretical understanding of donor behaviour and the effectiveness of interventions aimed at donor retention. In this study, we aim to identify types of blood and plasma donors based on factors that have been identified as central drivers of repeated blood donation behaviour, including constructs from an extended Theory of Planned Behaviour, prosocial values, and social network characteristics. We apply latent transition analysis to a large sample of blood and plasma donors in the Netherlands (N = 22128). We identify 4 classes of donors: the *balanced donors* (33%), the *exceptionally motivated donors* (18%), the *unfulfilled donors* (23%), and the *confident habitual donors* (26%). Further, we analyse the sociodemographic predictors of class membership, transitions between classes over time, and the association between class membership and long-term donor lapse. We discuss the implications of our typology for theories of repeat blood donation and strategies aimed at donor retention.

## 2.1 Introduction

Blood donations enable transfusions, many routine medical treatments (e.g., treatment of patients that suffered trauma or burn), and the production of plasma-derived medicinal products (Merz 2024; Slonim et al. 2014). Many countries rely on voluntary and non-remunerated whole blood and blood plasma donations (collectively referred to as blood donations below) to ensure a sufficient supply of blood transfusions and plasma products (Healy 2000; Slonim et al. 2014). For blood collection services, providing this supply poses a growing challenge due to an increasing demand for blood plasma, aging populations in many countries, and a shrinking number of whole blood donors (Ferguson et al. 2020; Grabowski and Manning 2016; Roberts et al. 2019). Blood collection services try to overcome this challenge by continuously developing their strategies aimed at donor recruitment and retention. Retaining a pool of loyal donors is often considered safer and more cost-effective than continuously recruiting one-off donors, and therefore a central goal of many blood banks (Dongen 2015; Masser et al. 2008). However, many donors lapse after their first or first few donations (Bagot et al. 2016; Masser et al. 2008).

To improve retention, it is necessary to understand what motivates blood and plasma donors to continuously donate blood. A large body of literature in tradition of the Theory of Planned Behaviour (TPB) (Ajzen 1991) has made considerable progress in uncovering these factors (Bagozzi 1996; Bednall et al. 2013; Masser et al. 2020). It has shown how individuals' attitudes, subjective norms, perceived behavioural control and intentions predict repeat blood donation. In addition, recent literature has additionally identified how prosocial values, demographics, and contextual factors come together with TPB constructs in their effect on repeat blood donation (Bednall et al. 2013; Ferguson et al. 2020; Masser et al. 2020; Piersma et al. 2017). Importantly, this body of literature has identified a broad range of factors that consistently predict repeated blood and plasma donation behaviour, and developed theoretical models of continued prosocial behaviour in the form of blood and plasma donations.

To a large extent, however, donors in these studies are treated as a homogeneous group. This assumption is problematic, as it limits both our understanding of donor behaviour and the effectiveness of interventions aimed at donor retention (Bove et al. 2021; Bryan et al. 2021; Clary and Snyder 1999). For example, while altruistic values are the most commonly cited motivation for giving blood, 25% to 30% of donors do not mention such a motivation (Bednall and Bove 2011; Ferguson et al. 2020). Understanding heterogeneity in motivations of blood donors is an important first step to matching retention strategies to donor types and thereby increasing their effectiveness (Bove et al. 2021; Bruhin et al. 2015; Romero-Domínguez et al. 2019).

In this study, we aim to provide a tangible classification of blood and plasma donors

based on cognitive, affective, sociodemographic, and social network characteristics, which have been identified as central drivers of repeated blood donation behaviour. Importantly, we do so without relying on prespecified assumptions about the existence of certain donor types. For our empirical analysis, we draw on a large and representative sample of blood and plasma donors in the Netherlands, which includes information about their motivations, sociodemographic characteristics, and donation behaviour from survey and register data. Applying latent profile analysis (LPA) and latent transition analysis (LTA) to this sample, we are able to identify distinct donor types and their respective share in the overall Dutch blood and plasma donor population. In addition, we analyse the factors that predict class membership, including donation experience. We further examine transitions between donor profiles over time, and to what extent these transitions are affected by crucial life events (such as childbirth) that that might lead to transitions from one class to another based on previous literature. Finally, we also analyse to what extent class-membership predicts long-term donor lapse, by examining whether donors are still active 10 years after we first observe them in our data.

### 2.1.1 Who is motivated to donate blood?

On the individual level, several groups of factors have been identified as crucial for understanding blood donor behaviour. First, one group of factors stems from extensive work on the TPB (Ajzen 1991) in relation to blood donation, and later extensions proposed to this model (Conner and Armitage 1998; Conner et al. 2013; Masser et al. 2009; Masser et al. 2020). The factors included in this group are cognitive and affective attitudes towards blood donation, subjective norms about blood donation, self-efficacy regarding blood donation (alternatively conceptualised as perceived behavioural control (Armitage and Conner 2001)), self-identity as a blood donor, blood donor habit formation, and moral norms about blood donation. All of these factors have been found to be positively associated with repeated blood donation behaviour (Bednall et al. 2013; Ferguson et al. 2012). A second group of factors stems from the literature on prosocial behaviour in general, and includes altruistic values, generalised social trust (referred to as trust below), and awareness of need. These factors have been identified as crucial factors determining charitable giving (Bekkers 2003; Bekkers and Wiepking 2011; Chapman et al. 2022), and are often among the top self-reported motivations for giving blood (Ferguson et al. 2020). Third, blood donation has long been known to be subject to social influences (Masser et al. 2008), and recent literature has provided empirical evidence on how other donors within one's social network affect repeated blood donation behaviour (Bruhin et al. 2020; Goette and Tripodi 2024; Schröder et al. 2023a; Schröder et al. 2023b). Fourth, a variety of socio-demographic variables and the recruitment channel have been shown to predict donor behaviour (Bednall et al. 2013; Masser et al. 2008; Piersma and Klinkenberg 2018; Piersma et al. 2017).

Finally, previous research has shown that life events, most notably childbirth and starting or losing a job, affect the probability of donor lapse (Charbonneau et al. 2016; Piersma, Bekkers, de Kort, and Merz 2019; Piersma, Merz, et al. 2019). In summary, these studies provide a better understanding of the motivations and characteristics of donors that are more likely to be retained, and a potential way forward for developing strategies aimed at donor retention.

### 2.1.2 Uncovering the heterogeneity of blood donor motivations

Some progress has been made towards unpacking the fact that not all donors are motivated by the same factors. With a focus on donor retention, several theoretical models have conceptualised donor motivation in relation to experience as a blood donor (Ferguson and Chandler 2005; Masser et al. 2008).

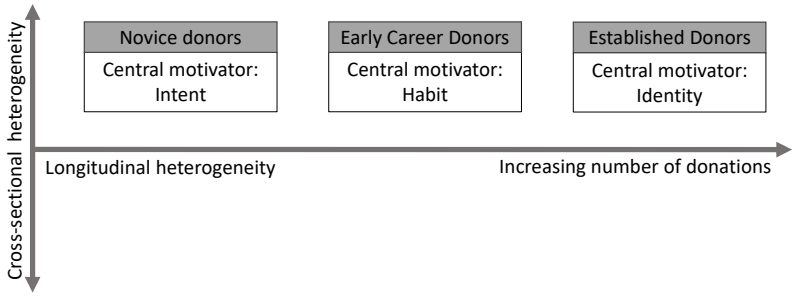



**Figure 2.1** Simplified stage model of the blood donor career (Masser et al. 2008), extended to include cross-sectional heterogeneity.

Figure 2.1 shows an adapted conceptual representation of the stage model developed by Masser et al. (2008), which specifically extends the TPB to better predict donor retention. This model distinguishes groups of donors based on their donation experience, often operationalized as the number of donations (Ferguson and Chandler 2005; Ferguson et al. 2012; Masser et al. 2008; Veldhuizen 2013; Veldhuizen et al. 2011). The central argument for this distinction is that motivational differences between donors develop as donors progress through their blood donor careers. Novice donors are assumed to be primarily motivated by factors included in the original TPB, namely intent, which is determined by their attitudes, normative influences, and self-efficacy. As donors gain more experience, they form habits and ultimately a role identity as a donor, which are the primary drivers of their donation behaviour (Masser et al. 2008; Piliavin et al. 2002; Veldhuizen 2013). Ferguson (2015) and Ferguson et al. (2012) furthermore suggest that additional motivations, such as a feeling of warm glow derived from making a donation or reluctant altruism (donating because one does not trust others to do so), map onto these stages of the donor career, such

that reluctant altruism is more important in the earlier stages, whereas warm glow gains in importance as the donor becomes more experienced.

The experience-based classification has the distinct advantage that it can be easily used by blood collection agencies to target retention strategies. However, it also has two marked disadvantages. The first shortcoming is that it only considers one dimension along which differences in donor motivation might emerge: donor experience. While some motivations might vary with the experience as a blood donor and therefore result in longitudinal heterogeneity, the model does not consider heterogeneity in the donor population at any one point in time  what we call cross-sectional heterogeneity in Figure 2.1. However, identifying heterogeneity in donor types and their associations with observable characteristics and donor lapse is of particular significance for retention strategies of blood collection services. For example, Bruhin et al. (2015) have shown that the effectiveness of invitations to donate, a tool commonly used by many blood collection services, varies between donors depending on their baseline motivation to donate. The second shortcoming of the experience-based classification is that transitions between the stages of novice donor, early career donor, and experienced donor over time are conceptualised as necessarily related to donation experience, irrespective of actual changes in the factors that drive the behaviour of blood and plasma donors. While some donors might follow the path from novice donor (motivated by intent), to early career donor (motivated by habit), to established donor (motivated by donor identity), it is highly unlikely that all donors follow this path. For example, previous research has shown that life events such as childbirth also affect donation behaviour (Piersma, Bekkers, de Kort, and Merz 2019; Piersma, Merz, et al. 2019), presumably because they disrupt the process of habit formation and set up donors for a different path in their donor career. For blood banks, identifying such alternative paths is particularly important as a large proportion of donors does not make it past the first few donations in their donor career (Bagot et al. 2016; Dongen 2015; Masser et al. 2008).

Several recent studies have also suggested typologies for understanding cross-sectional heterogeneity in blood donor motivation. Focused on donor identity and using in-depth interviews, Bove et al. (2021) have demonstrated that donors in Australia are not homogeneously motivated by a goal to save lives (those that are, are labelled 'saviours'). Many donors are instead mainly motivated by the goal to benefit their community ('communitarians'), have a pragmatic view of blood donation ('pragmatists'), or want to display their special competence ('elitists'). In addition, these groups vary in their perceptions of the personal costs of donating, and their expectations about rewards and recognition from their social network. In a segmentation of the Spanish donor population based on their perceived barriers to donate, Romero-Domínguez et al. (2019) identified groups of 'very inhibited' (overall high level of perceived barriers), 'uninhibited' (overall low level of perceived barriers), 'apprehensive' (high level of intrinsic barriers), and 'busy' (high level of time-space barriers) donors. Both studies show that at one point in time, there is a large amount of

heterogeneity in the motivations and perceived barriers for blood donation. A limitation of these studies, however, is the lack of attention to changes in motivational profiles over time.

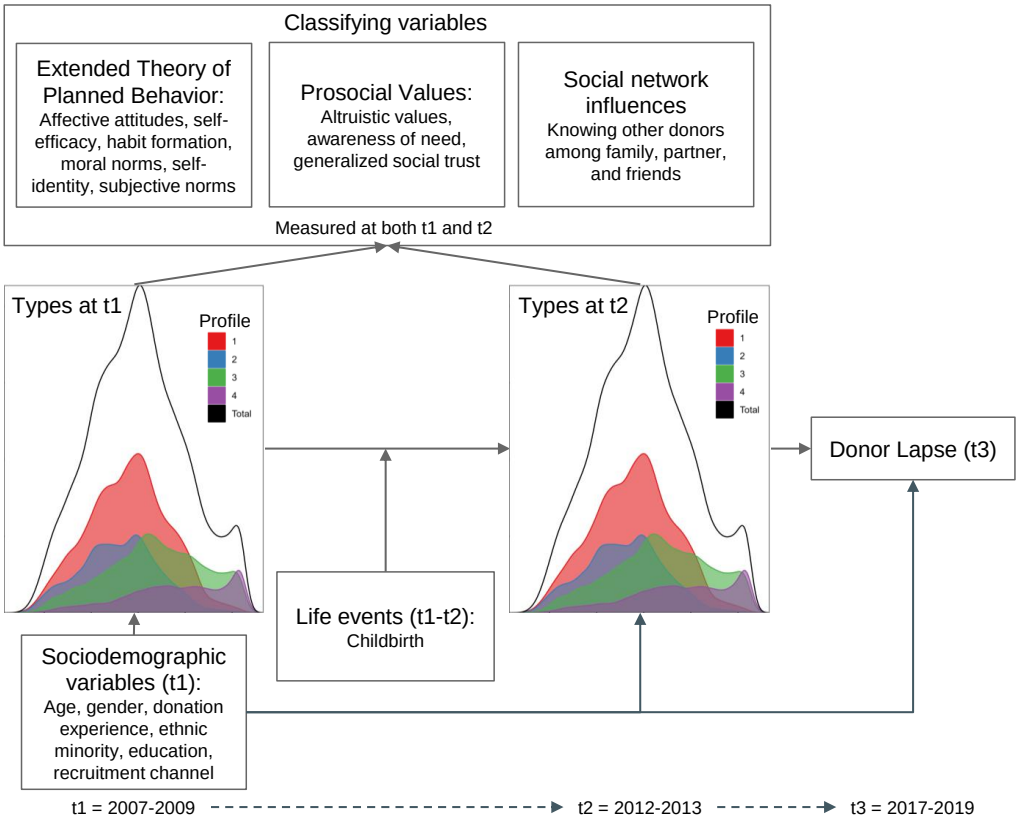



**Figure 2.2** Overview of the study design.
Notes: The profiles at t1 and t2 are identified based on the classifying variables. Sociodemographic characteristics are used to predict the likelihood of membership in certain donor types at t1 and t2. Transitions between types are represented by the arrow between profiles at t1 and t2. The influence of life-events on transitions is represented by the arrow from life events to arrow between profiles at t1 and t2. The arrow between profiles at t2 and donor lapse represents the test for whether donor types are predictive of long-term donor lapse.

A conceptual overview of the study design is given in Figure 2.2. This paper aims to synthesise the previous literature by showing a) how a multitude of attitudinal and motivational factors that have been identified in the prior literature come together to create distinct types of blood and plasma donors, b) to what extent class membership is predicted by sociodemographic variables, c) the transitions between classes over time, d) the effect of life events on transitions between classes, and e) the effect of class membership on long-term donor lapse.

## 2.2 Materials and methods

### 2.2.1 Study population

The data for this study consists of two waves of survey data from the Donor InSight (DIS) study (Timmer et al. 2019) and register data from the Sanquin donor database (eProgesa, 5.03; Maksystem, Paris, France). Sanquin is the official and only authorized blood collection organisation in the Netherlands. Blood donations in the Netherlands are always voluntary and non-remunerated. The DIS study is a cohort study conducted by Sanquin to gain more insight into donor characteristics, motivation, and health. The Donor InSight study was approved by the Medical Ethical Committee Arnhem-Nijmegen in the Netherlands [CMO-nr: 2005/119]. All participants gave their written, informed consent. This study was approved by the Research Ethics Review Committee (RERC) of the Faculty of Social Sciences, Vrije Universiteit Amsterdam [reference number RERC/18-10-08]. In this study, we use the anonymous self-administered questionnaire rounds from DISI in 2007-2009 (N = 31338) and DISII in 2012-2013 (N = 34826). See Timmer et al. (2019) for additional details on the DIS study. In our main analysis, we use the panel data set on 22132 (63.6%) of the donors that participated in both DIS-I and DIS-II. We linked the DIS data to routinely collected register data from the blood bank's donor database to be able to examine long-term donor lapse.

### 2.2.2 Latent profile and latent transition analysis

Latent profile analysis (LPA) and latent transition analysis (LTA) are uniquely suited methods to uncover heterogeneity in types of blood donors and transitions between donor types over time. They allow for a model-based analysis of heterogeneity without prespecified assumptions about the existence of certain donor types, account for the fact that the membership in the recovered groups is uncertain and can be extended for the analysis of predictors of class-membership, transition probabilities, and distal outcomes (Nylund-Gibson et al. 2023; Oberski 2016).

Our analysis consists of four steps. First, we conduct class enumeration via separate LPAs for both time points of the panel sample (Johnson 2021; Nylund-Gibson et al. 2023). To decrease computational burden, LPA typically assumes that variances of indicators are equal across classes, and that covariances between indicators are zero after accounting for class-membership (Masyn 2013). We refer to the model with these assumptions as model 1. However, more flexible specifications might provide a better representation of the data. We therefore also estimate a specification where the estimated variances of indicators are allowed to vary across classes (i.e. model 2). Due to the lack of strong underlying theory that informs us on the number of classes to extract, we determined the final number

of classes based on statistical fit indices, interpretability, and theoretical meaningfulness (Collins and Lanza 2010; Johnson 2021; Morgan 2015; Nylund et al. 2007; Nylund-Gibson et al. 2023). As fit indices for the model comparison we use the log-likelihood, the Akaike Information Criterion (AIC) (Akaike 1987), the Consistent Akaike information criterion (CAIC), the Bayesian information criterion (BIC) (Schwarz 1978), the sample size adjusted BIC (SABIC) (Sclove 1987), and the integrated completed likelihood (ICL) (Biernacki et al. 2000). We further determined the final number of classes based on interpretability and generalizability, as fit indices might indicate a solution that is not theoretically meaningful, especially when the sample size is large (Collins and Lanza 2010).

In the second step, we estimate the LTA model specified with the number of classes arrived upon in the class-enumeration process (i.e., step 1), and the estimates from each LPA model as starting values. We specify the LTA with measurement invariance of classes across time, as the extracted profiles are very similar across both time points. Using the LTA, we estimate transition probabilities between donor types from time point 1 (i.e., DIS-I) to time point 2 (i.e., DIS-II).

In the third step, we assess predictors of class membership and predictors of class transitions using multinomial logistic regression. We use sociodemographic variables, recruitment channel, and donor experience as predictors of class membership. For the analysis of predictors of transition probabilities, we include childbirth as an additional predictor.

In the final step, we assessed to what extent class membership at time point 2 predicts long-term donor lapse (i.e., the distal outcome). As covariates, we include sociodemographic variables, the recruitment channel, experience, and a dummy variable for reaching the maximum age for being eligible for donating at the end of the follow-up period (ineligible = 1). In step three and step four, we confirmed that the class-item correspondence does not change substantially after including the covariates and the distal outcome in the LTA.

All pre-processing of data was conducted in R (version 4.3.0) (R Core Team, 2021). For the LPA and LTA, we used Mplus Version 8.10 (Muthén and Muthén 2017) via the MplusAutomation (Hallquist and Wiley 2018) and tidyLPA (Rosenberg et al. 2019) packages in R. Code used for the analysis is available at the Open Science Framework (OSF) project page: https://osf.io/zcfta/.

### 2.2.3 Measures

#### Classifying variables

For the classification of donors, we use three groups of factors: extended TPB variables, prosocial values, and knowing other donors as a proxy for social network influences. We use confirmatory factor analysis (CFA) to assess the reliability of multi-item attitudinal measures, to confirm longitudinal measurement invariance of these constructs, and to ob-

tain factor scores of latent variables (for details see Appendix section A2.1).

**Extended TPB measures**

Self-efficacy, habit formation, moral norms, and self-identity were measured on five-point Likert scales (1 fully disagree to 5 fully agree) based on the items in Appendix Table A2.2. Affective attitudes were measured using three statements on a five-point scale in response to the statements in Appendix Table A2.2. Subjective norms were measured on a five-point scale (1 fully disagree to 5 fully agree) based on the statement "My family and friends think that I should continue giving blood as long as my health allows it." For more details about the measures from the extended TPB we refer to Ferguson et al. (2012) and Veldhuizen et al. (2012).

**Prosocial values**

Altruistic values are measured using a five-point Likert scale based on the items in Appendix Table A2.2. Generalized social trust was measured using a five-point scale based on the item: "In general, most people can be trusted" (Bekkers 2003). Awareness of need for blood donations was measured on a five-point scale (1 totally disagree to 5 totally agree) based on the items in Appendix Table A2.2.

**Social network characteristics**

To measure the prevalence of blood/plasma donation within a donor's social network, we use the extent to which donors have other donors among their family, friends, and partners. Participants were asked "Do you have people in your immediate surroundings who are blood / plasma donors?", and the response options were "yes, partner", "yes, family", "yes, friends or acquaintances", and "no". We use the number of categories of social relations that are tied to blood donation as a classification variable, which ranges from 0 to 3.

**Predictors of class membership**

For the prediction of class membership, we use a range of socio-demographic variables that are often routinely measured by blood banks and therefore useful for targeted intervention strategies. We included sex (female = 1), age (in years), donation experience (log of the number of previous donations), identification as member of an ethnic minority (defined as non-Dutch, ethnic minority = 1), and the highest level of education achieved (0 = none, 7 = university degree). The recruitment channel was elicited using the question "What made you decide to become a donor?", and response options were "own initiative", "blood bank brochure", "blood bank canvas for new donors", "newspaper", "Internet", "family", "friends

or acquaintances", and "other", where multiple response options were possible. These answers were recoded into three dummy variables indicating whether a donor indicated this recruitment channel, potentially among other channels: Own initiative (response option 1, reference category), Sanquin media/ads (response options 2-5), and partner, family and friends (response options 6-7).

**Predictors of transitions**

Life-events such as childbirth, losing a job, and health-related events among family members have previously been found to impact donor careers (Piersma, Bekkers, de Kort, and Merz 2019; Piersma, Merz, et al. 2019). Here, we analyse the crucial event of childbirth, for which data is available for our whole sample. We are interested in the extent to which childbirth predicts transitions between motivational classes of donors, and we therefore measure childbirth between the two survey waves. The binary variable childbirth takes the value 1 if a child was born to the donor in the years between participation in DIS-I and DIS-II (regardless of whether it was their first child or not), and the value 0 otherwise.

**Distal outcome: Donor lapse**

In line with previous literature, a lapsed donor is defined as someone who did not donate over the course of the last two years (Piersma, Bekkers, de Kort, and Merz 2019). This operationalisation is also used by the blood bank: after not having donated for two years, donors are typically not contacted anymore because it is assumed that they will no longer donate. To assess long-term donor lapse, we selected the date 10 years after participation in DIS-I as the end of the follow-up and we checked whether donors made at least one donation in the two years prior to the end of the follow-up. The 10-year period provides a long-term view on donor lapse while ensuring that the majority of donors are still eligible to donate based on age-eligibility. If no donation was made in the last two years of the 10-year follow-up, the donor was recorded as lapsed donor (lapsed = 1), and other donors are recorded as active donors (lapsed = 0).

**Descriptive statistics**

Table 2.1 shows descriptive statistics of the study measures for the DIS-I and DIS-II panel data sample. For the LPA and LTA, all variables were z-standardised to facilitate model estimation, class identification, and the visualisation and interpretation of results (Van Lissa et al. 2023).

**Table 2.1** Descriptive statistics of study measures

| | N | Mean | SD | Min. | Max. |
|---|---|---|---|---|---|
| *DIS-I classifying variables* | | | | | |
| Affective attitudes (DIS-I) | 21245 | 3.54 | 0.78 | 1 | 5 |
| Self-efficacy (DIS-I) | 21911 | 4.53 | 0.63 | 1 | 5 |
| Habit formation (DIS-I) | 21915 | 4.37 | 0.75 | 1 | 5 |
| Moral norms (DIS-I) | 21916 | 3.06 | 1.00 | 1 | 5 |
| Self-identity (DIS-I) | 21916 | 3.70 | 0.85 | 1 | 5 |
| Altruistic values (DIS-I) | 22059 | 3.78 | 0.57 | 1 | 5 |
| Trust (DIS-I) | 22047 | 3.67 | 0.77 | 1 | 5 |
| Subjective norms (DIS-I) | 21627 | 2.98 | 1.28 | 1 | 5 |
| Awareness of need (DIS-I) | 21763 | 4.36 | 0.73 | 1 | 5 |
| Knowing other donors (DIS-I) | 22000 | 1.01 | 0.72 | 0 | 3 |
| *DIS-II classifying variables* | | | | | |
| Affective attitudes (DIS-II) | 21609 | 3.72 | 0.79 | 1 | 5 |
| Self-efficacy (DIS-II) | 22060 | 4.54 | 0.73 | 1 | 5 |
| Habit formation (DIS-II) | 22073 | 4.38 | 0.82 | 1 | 5 |
| Moral norms (DIS-II) | 22062 | 3.10 | 1.00 | 1 | 5 |
| Self-identity (DIS-II) | 22063 | 3.67 | 0.92 | 1 | 5 |
| Altruistic values (DIS-II) | 22057 | 3.81 | 0.59 | 1 | 5 |
| Trust (DIS-II) | 22047 | 3.75 | 0.76 | 1 | 5 |
| Subjective norms (DIS-II) | 21859 | 2.93 | 1.34 | 1 | 5 |
| Awareness of need (DIS-II) | 22086 | 4.36 | 0.71 | 1 | 5 |
| Knowing other donors (DIS-II) | 22128 | 0.96 | 0.74 | 0 | 3 |
| *Socio-demographic variables* | | | | | |
| Female (DIS-I) | 22128 | 0.53 | 0.50 | 0 | 1 |
| Ethnic minority (DIS-I) | 22054 | 0.02 | 0.15 | 0 | 1 |
| Education (DIS-I) | 22033 | 5.45 | 1.68 | 1 | 8 |
| Working hours (DIS-I) | 17573 | 31.30 | 11.18 | 0 | 99 |
| Experience (DIS-I) | 22003 | 2.20 | 0.67 | 0 | 4.5 |
| Age (DIS-I) | 22125 | 46.63 | 12.33 | 18 | 70 |
| Childbirth (DIS-I-DIS-II) | 22128 | 0.08 | 0.26 | 0 | 1 |
| *Distal outcome* | | | | | |
| Donor lapse | 22128 | 0.49 | 0.50 | 0 | 1 |

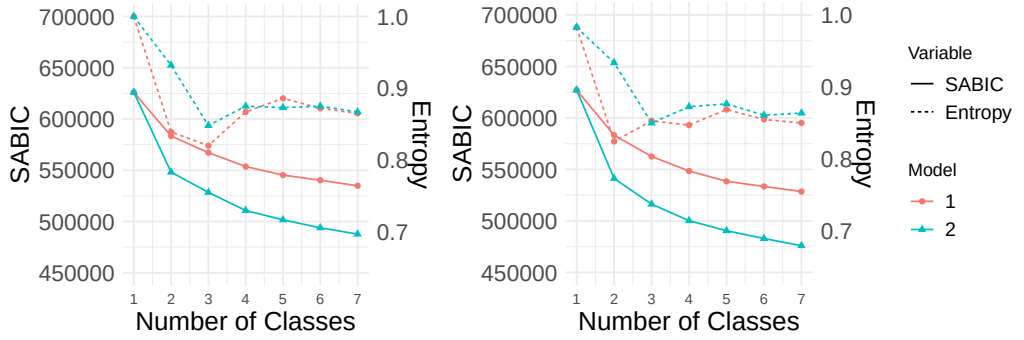
Notes: Descriptive statistics for multi-item attitudinal measures are based on mean-scores of the corresponding items. In the LPA and LTA, we use factor scores based on the CFA (see Appendix section A2.1 for details on the CFA procedure).

## 2.3 Results

### 2.3.1 Class enumeration

For class enumeration, we start by comparing fit indices for the estimated models. Figure 2.3 shows an elbow plot of the SABIC and relative entropy for the estimated models at both time points. First, the SABIC shows that the fit to the data is substantially improved in models with more than one class, indicating that there is heterogeneity in the blood donor population (Van Lissa et al. 2023). The SABIC further indicates that model 2, which allows variances of indicators to vary across classes, has a better fit to the data than model 1 in which variances are assumed to be equal. In addition, it shows that model 2 with seven classes has the overall best fit. While SABIC keeps decreasing with an increasing number of classes, the rate of improvement in the goodness of fit strongly decreases for models with more than four classes. The additional fit indices, LL, AIC, CAIC, BIC, and ICL shown in Appendix Table A2.3, all show very similar patterns and agree with the SABIC that Model 2 with seven (or more) classes is the best fitting model and show a levelling off for models with more than four classes. Relative entropy values around 0.85-0.9 (see Figure 2.3) further show that the separation between classes for all models is good, and usually slightly better for the classes extracted based on model 2. As an additional robustness check, we also conducted the class-enumeration for the full sample of DIS-I donors (as opposed to only those that participated in both DIS-I and DIS-II). We confirm that the number of extracted classes (see Appendix Table A2.4) and the class-item correspondence are not significantly different when using the full DIS-I sample (see Appendix Figure A2.3). This finding provides some reassurance that the findings are generalizable to the broader population of donors. In summary, the statistical fit indices show that models estimated with variances allowed to vary between classes (model 2) show substantially better fit to the data than models with equal variances assumed (model 1), that the fit improves for models with up to seven classes, and that there is a decrease in the rate of improvement for models with more than four classes.

Next, we examine the structure of the estimated profiles for models with two to seven classes to determine their distinctness and theoretical meaningfulness. Appendix Figure A2.1 and Appendix Figure A2.2 show profile plots for models with two to seven classes estimated based on model 2 for DIS-I and DIS-II, respectively. Based on the estimated profiles, the model with four classes seems to be the most informative one. Models with fewer classes miss classes that we consider theoretically informative based on our interpretation below, while the models with more than four classes extract classes that are only marginally different from the existing classes. Below, we describe the extracted donor profiles based on the four-class solution based on model 2.




**(a)** DIS-I **(b)** DIS-II

**Figure 2.3** Sample size adjusted BIC (SABIC) and relative entropy for DIS-I (left) and DIS-II (right).
Notes: Models 1 and 2 use the same classifying variables, but model 1 assumes equal variances of indicators across classes, while model 2 allows them to vary.

### 2.3.2 Donor profiles

The estimated class profiles based on the LTA including both time points are shown in Panel A of Figure 2.4. In general, we can see that the classes extract substantial heterogeneity that is present in the Dutch donor population. However, we observe that two variables do not substantially contribute to the differentiation of donor types, namely trust and knowing other donors. Across classes, donors tend to agree that most people can be trusted (trust), and they have one category of social relations that is tied to blood donation (knowing other donors). For the other variables, we see marked differences between the four classes. There is a large class of donors of about 33% of the sample that scores about average on most constructs, which we label the balanced donors. In addition, two classes emerge that cover each side of the spectrum from low to high motivation: one class of about 23% of the sample that scores low on most constructs, and one class of about 18% that scores high on most constructs. We label these classes the unfulfilled donors and the exceptionally motivated donors, respectively. Finally, a fourth class of about 26% of the sample emerges that is high on self-efficacy and habit formation almost as high as the exceptionally motivated donors, but only about average on most other constructs. We label this class the confident habitual donors. Below, we describe each of the classes in more detail.

The *balanced donors* (Class 2): The balanced donors, approximately 33% of our sample, are a good point of comparison for the other donor profiles. They score about average or slightly below average on all constructs. Most notable are their below average levels of habit formation and self-efficacy, which are estimated to be about one third of a standard deviation below the mean. In terms of absolute values (also see Table 2.1), the balanced

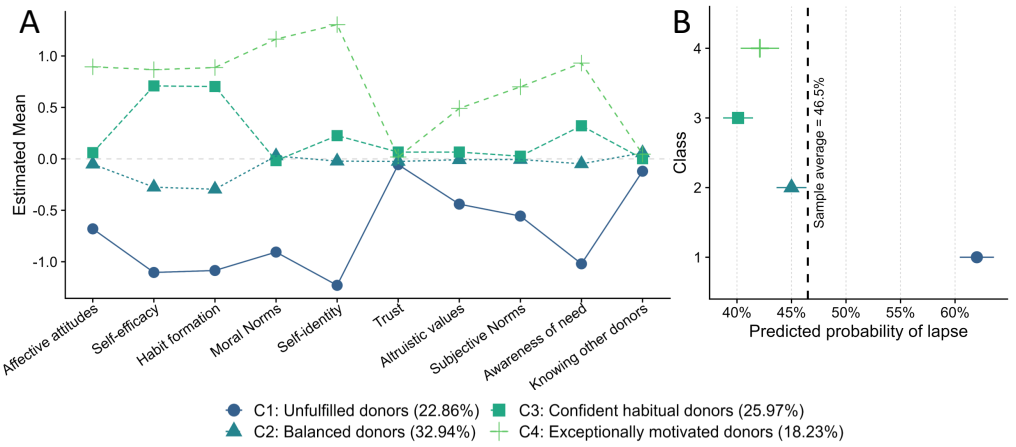



**Figure 2.4** Item-class correspondence and associations between class-membership and donor lapse for the selected four-class solution. Panel A: Profile plot of estimated means of the 10 indicators within each of the 4 classes. Panel B: Coefficient plot of the association between class membership and the predicted probability of donor lapse.
Notes: All variables were standardised such that they have a mean of zero and a standard deviation of one. Donors are considered lapsed if they have not donated within the last two years of the 10-year follow-up period. All covariates are held at the mean, except for the age-ineligibility dummy, which is held at 0. Estimated class sizes are for time point 1.

donors perceive blood donation as slightly more enjoyable than annoying (affective attitudes), agree that they are capable of keep donating blood/plasma as long as their health allows it (self-efficacy), that they would naturally go to the blood bank when they are invited to donate (habit formation), neither agree nor disagree that they feel morally obliged to give blood (moral norms), agree that being a blood donor is an important part of who they are (self-identity as a blood donor), and neither disagree nor agree that their family and friends think that they should continue giving blood as long as their health allows it (subjective norms). In terms of prosocial values, the balanced donor tends to agree that it is important to help others (altruistic values) and is in between agreeing and completely agreeing that their blood is needed (awareness of need). Panel B of Figure 2.4 shows that donors in this class have about a 45% probability of lapsing over the course of the next 10 years, which is just below average in comparison to the overall sample.

The *unfulfilled donors* (Class 1). This group of donors (approx. 23% of the sample) scores below average on all constructs. The prototypical donor in this group is less affectively attached to blood donation and does not perceive a strong awareness of need, moral norms, or subjective norms in relation to blood donation. In addition, they do not feel like they are easily able to fit blood donation into their current or future lives, and they have not at all made a habit out of donating blood. Accordingly, they also strongly disagree that being a blood donor is a part of their identity. Finally, these donors have low altruistic

values compared to the overall sample and are slightly less likely to know other donors. In Panel B of Figure 2.4 we can see that with about 62%, donors in this class have a much higher probability of lapsing compared to members of the other classes.

The *exceptionally motivated donors* (Class 4). About 18% of the sample are classified as exceptionally motivated donors, who score strongly above average on most constructs. They score between 0.5 and 1.5 standard deviations above average on all extended TPB indicators, and additionally show above average altruistic values. What most strongly sets them apart from all other classes are their high affective attitudes towards blood/plasma donation, high self-identity as blood/plasma donor, and strong moral and subjective norms about blood/plasma donation. Panel B of Figure 2.4 shows that, with a 42% predicted probability of lapse, these donors are less likely than average to lapse over the following years. Surprisingly, however, even though they seem to be highly motivated to donate, they do not actually have the lowest probability of donor lapse of all donor classes.

The *confident habitual donors* (Class 3): The class of confident habitual donors makes up about 26% of the sample and shows a unique pattern of motivation. Donors in this class score three quarters of a standard deviation higher than average in terms of habit formation and self-efficacy almost as high as the exceptionally motivated donors. In addition, they are about a third of a standard deviation above average on awareness of need for blood donations and self-identity as a blood donor. On the other constructs, however, these donors only score about average. This group seems to be well aware that their blood is needed, are able to fit blood donation into their lives, and have made a strong habit out of donating blood. However, they are not particularly affectively attached to blood donation, have average altruistic values, and they do not perceive strong moral or subjective norms about blood donation. Panel B of Figure 2.4 shows that this group has the lowest predicted probability of lapse at 40%, even lower than that of the exceptionally motivated donors.

### 2.3.3 Predictors of class membership

Figure 2.5 shows the predictors of membership in the classes 1-3, where the class of exceptionally motivated donors is the reference group. The results show that donors that were recruited by the blood bank or another donor (as opposed to signing up on their own initiative) are more likely to be members of classes 1-3, with recruitment by the blood bank being the stronger predictor. Donors with lots of donation experience are most likely to be in the class of exceptionally motivated donors, as indicated by negative odds ratios for membership in classes 1-3. Female donors are less likely to be balanced donors or unfulfilled donors and slightly more likely to be confident habitual donors than exceptionally motivated donors. The higher the level of education, the less likely donors are to be in the class of exceptionally motivated donors and the more likely they are to be in the class of unfulfilled donors. Ethnic minority donors are most likely to be exceptionally motivated

donors and have slightly lower odds of being a member of any of the other classes. Childbirth is not significantly associated with membership in any of the classes. Finally, older donors are more likely to be in the exceptionally motivated class than in any of the other classes.

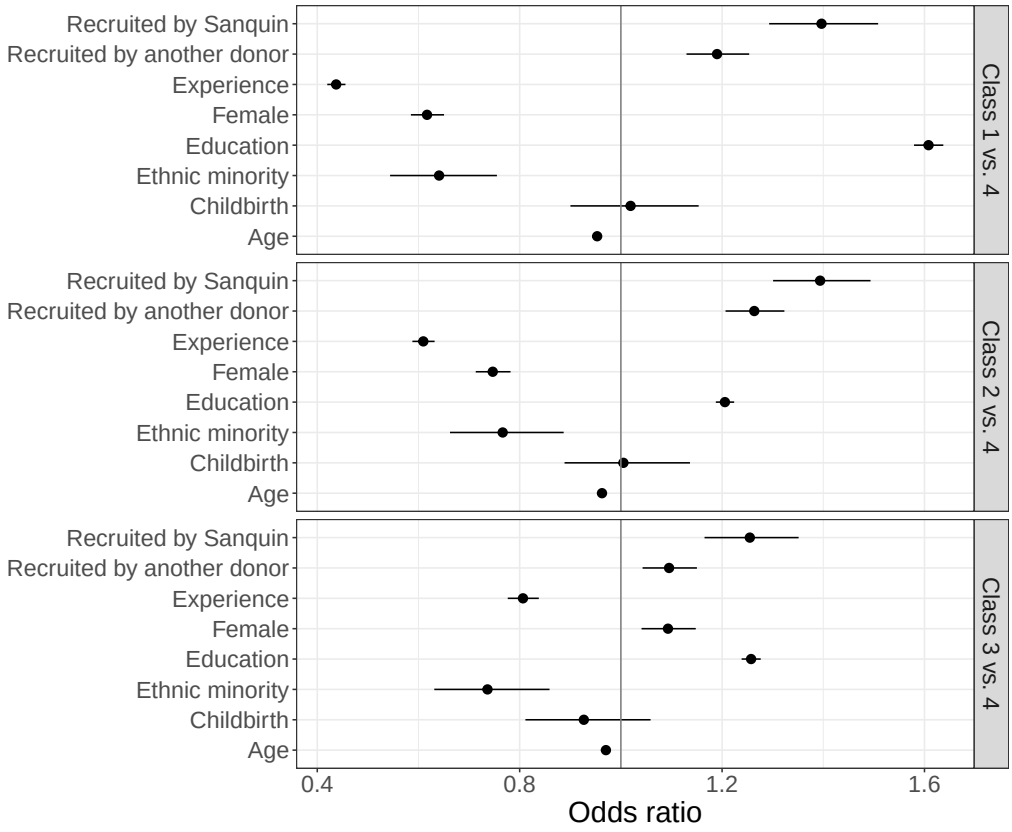



**Figure 2.5** Predictors of class membership.
Notes: Class 1: Unfulfilled donors; Class 2: Balanced donors; Class 3: Confident habitual donors; Class 4: Exceptionally motivated donors.

### 2.3.4 Transitions between classes over time

Figure 2.6 shows the probabilities of donors transitioning from one class to another between period one and period two. Unfulfilled donors show the highest degree of stability across all classes: about 73% of the unfulfilled donors are predicted to remain in that class. There is about a 15% probability of unfulfilled donors transitioning to the class of balanced donors or that of confident habitual donors, while the probability of transitioning to class of exceptionally motivated donors is estimated to be 0%. Balanced donors are predicted to

stay within their class with a 57% probability. Additionally, they have a low probability of 7% and 9% to transition to the class of unfulfilled or exceptionally motivated donors, respectively. They also have a 27% probability to transition to the class of confident habitual donors.

The confident habitual donors have a predicted probability of 50% of staying within their class. They have about a 10% probability of transitioning to the classes of exceptionally motivated donors or unfulfilled donors. In addition, they have about a 30% probability of transitioning to the class of balanced donors.

The exceptionally motivated donors are predicted to stay in their class with a probability of 57%. These exceptionally motivates donors are very unlikely (1% probability) to transition to the class of unfulfilled donors. Finally, they have a 18% probability of transitioning to the class of confident habitual donor, and about a 24% probability of transitioning to the class of balanced donors.

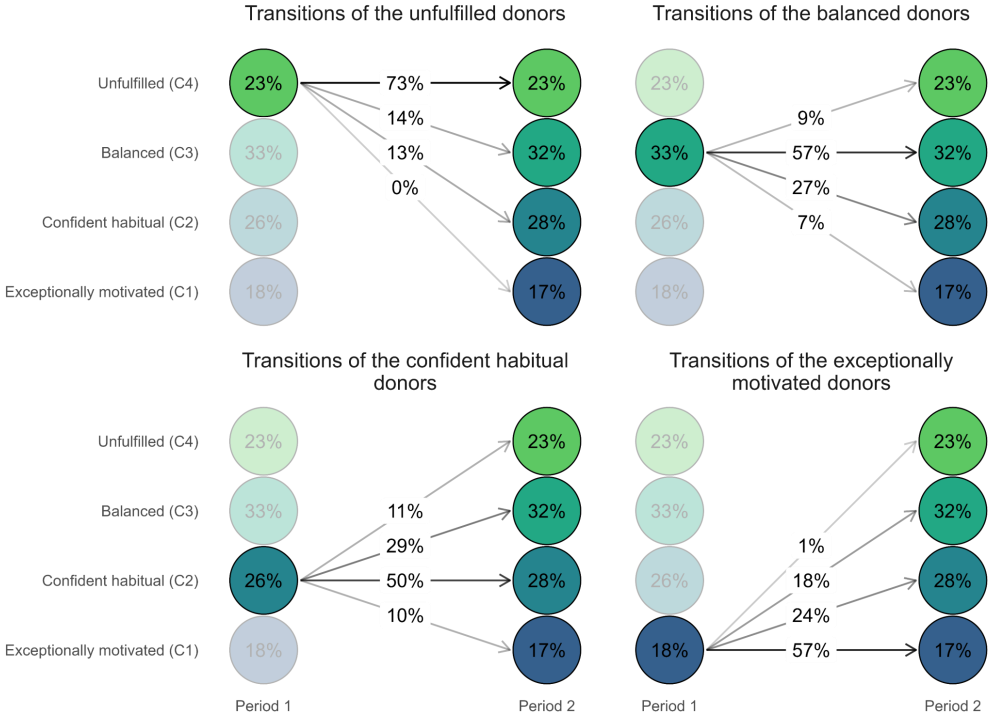



**Figure 2.6** Transition probabilities between period one and period two for each class.
Notes: Circles represent the classes including the estimated class size as a proportion of the total sample. Arrows indicate transition probabilities between classes.

Our results further show that childbirth increases the odds of transitioning from confident habitual donor to unfulfilled donor (OR = 1.281, 95% CI = 1.046, 1.569). Conversely,

childbirth decreases the odds of transitioning from unfulfilled donors to confident habitual donor (OR = 0.781, 95% CI = 0.637, 0.956). The other transition probabilities are not significantly associated with childbirth.

## 2.4 Discussion

Our study of a large sample of blood and plasma donors in the Netherlands reveals several types of blood and plasma donors that vary in their motivations for giving blood/plasma, their sociodemographic composition, and their long-term donor lapse. We find three classes of donors that are similar in their long-term donor lapse (40-45% probability of lapse), but different in their motivations. The group of balanced donors scores about average on all motivational constructs; the group of confident habitual donors scores high on self-efficacy and habit formation and average on most other constructs; and the group of exceptionally motivated donors scores very high on all motivational constructs. Interestingly, these differences in motivational profiles do not directly translate to predictable differences in donor lapse. In comparison to the balanced donors, the exceptionally motivated donors have only a slightly lower predicted probability of lapse. In comparison to the confident habitual donors, the exceptionally motivated donors even have a slightly higher predicted probability of donor lapse. Our results also show that there is quite some mobility between these classes over the course of three to four years between DIS-I and DIS-II. Donors in these classes have about a 50% probability of staying within their class, and between 10 to 30% probability of transitioning to one of the other two more motivated classes. In addition, we find a class of unfulfilled donors that scores low on most constructs and has a much higher probability of long-term lapse at 62% than any of the other donor classes. With a 73% predicted probability of staying in their class, the unfulfilled donors also show a large degree of stability over the course of three or four years and are therefore relatively unlikely to move to one of the more motivated classes.

### 2.4.1 Contributions to theory and practice

There are several complementarities between our results and previous studies of heterogeneity in blood donor motivations. In line with the experience based TPB model of repeat blood donation, we find that experience as a donor predicts being in the more motivated classes, indicating that as donors gain experience, they also take on values that are more positive about blood donation, and specifically habit, self-efficacy, and self-identity, which are higher among the confident habitual donors as well as the exceptionally motivated donors. Further in line with the experience-based classifications, self-efficacy and habit formation are important constructs that differentiate donors. In contrast to this model, however, an exceptionally strong self-identity as a blood donor might not be strictly neces-

sary for a long donor career. In fact, those donors in our sample that do not score particularly high on donor identity (but do on self-efficacy and habit formation) have the highest probability of remaining a donor in the long term. In addition, our analysis shows that there is substantial heterogeneity and stability in donor types over time, implicating that donor careers cannot be understood to uniformly evolve along with their experience as a blood donor.

Our analysis also shows similarities to the results of the segmentation of Australian donors by Bove et al. (2021). The class of confident habitual donors that we identify shows similarities to the pragmatist group of donors identified by Bove et al. (2021, p. 77): "They donate blood simply because they know there is a need for it, it serves a purpose, and they can do it", as indicated by the above average awareness of need and high self-efficacy and habit formation of confident habitual donors. In addition, pragmatist donors do not have a particularly strong emotional connection to blood donation, similar to our class of confident habitual donors, as indicated by average levels of affective attitudes.

Complementary to the analysis of barriers to donation by Romero-Domínguez et al. (2019), our findings similarly reveal a part of the donor population that is generally very motivated and easily able to donate, and one group that does not feel motivated and capable of donating. Extending these findings, our results show that there is a large degree of stability in the group of unfulfilled (or 'very inhibited') donors, who are likely to be more highly educated, very likely to stay within their class over the course of three to four years, and who have a high probability of donor lapse in the long term. A complementary insight provided by Romero-Domínguez et al. (2019) is to demonstrate the additional importance of fear and anxiety as a barrier to blood donation, which was not included in our classification. In summary, our analysis and its extensions and complementarities to previous studies of donor behaviour show that to understand donor retention, we need to consider both cross-sectional heterogeneity and longitudinal heterogeneity in donor motivations.

Relevant for the practice of blood banks, our results show that self-efficacy and habit formation are particularly important characteristics of donors that are more likely to be retained for a long time. We therefore echo recommendations of previous literature to make blood donation easy and convenient, for example by providing donors with easy access to donation sites (Piersma et al. 2021), generous opening hours and a convenient donation experience (Merz et al. 2017), or even making blood donation a truly planned and routine behaviour (Ferguson et al. 2007), e.g., via implementation intentions (if-then plans), or offering default appointments. Such interventions could potentially help unfulfilled donors to transition to one of the other classes in the medium term. We further found that donors that signed up on their own initiative are more likely to be in the classes of more motivated donors, especially when compared to those that were recruited via traditional marketing campaigns (brochures, newspapers, or internet). This may be because donors that sign up on their own initiative perceive higher psychological ownership of their behaviour and

the blood bank, which has been shown to be related to self-identity as a blood donor and intentions to donate blood (Edwards et al. 2023). It might therefore be worth trying to increase the potential for self-selecting into becoming a blood donor, since those who do are more likely to be retained for a longer time. Part of the donor recruitment strategy could therefore be aimed at increasing the awareness for blood donation, and to make it as easy as possible for these donors to follow through on the increased awareness of need by donating blood. Finally, our results show that it does not matter too much for donor lapse whether donors are exceptionally motivated or about average in terms of their motivation. What makes a big difference is if donors are generally low on most constructs related to blood donation. Blood banks might therefore primarily aim to avoid that donors end up in the class of unfulfilled donors.

### 2.4.2 Limitations and future research

A limitation of our study is the limited generalisability beyond the Netherlands. While our analysis was performed in a blood collection system that is similarly found in other countries  a voluntary non-remunerated non-profit run monopoly system  there is a broad range of different institutional arrangements and variations of this system for the collection of blood and plasma, for example in terms of the incentives that are offered to donors. Such different institutional arrangements will likely attract different types of donors (Healy 2000) and may result in varying compositions of the donor population. We might therefore also expect differences in blood donor profiles across cultural and institutional contexts. For example, Geiser et al. (2014) have shown that motivational profiles of volunteers are not identical across countries, and replications of our analyses in different contexts could reveal such differences. Another limitation of our study is that we only look at one outcome that is relevant for blood banks, namely donor lapse. There might be other relevant criteria, such as donation frequency or the total number of donations. For example, Piersma and Klinkenberg (2018) assessed the recruitment channel in relation to the number of donations made. They similarly found that donors that sign up on their own initiative have a higher donation frequency than donors recruited via traditional marketing strategies, but they also found that donors recruited by other donors have a slightly higher donation frequency than other groups. A further limitation may be that the sample of donors that participated in both waves of the survey is not representative of the overall donor population. However, we have shown that similar profiles emerge in a broader sample of donors that is representative of the overall donor population, and van Dongen et al. (2013) have shown that survey participants and non-participants are similar at least in terms of their donation behaviour. Another limitation of the DIS survey is the low composite reliability of the measure for awareness of need. Since there is no validated scale to measure awareness of need for blood donations, it should be developed in future work. An interesting extension

of our study would be the analysis of non-donors, which have previously been segmented by Martín-Santana et al. (2021), and to observe them over time to be able to track the whole process from recruitment to staying or lapsing as a donor in the long term. This would also allow us to see whether unfulfilled donors already start their donor career comparatively low in motivation, or whether they have become unfulfilled over the course of their career, potentially due to live events or negative experiences with the blood bank.

## 2.5 Conclusion

This study contributes to the literature by showing that there are several types of donors that vary along their cognitive, affective, sociodemographic, and social network characteristics. In addition, we show that donors often transition between these types over time and in relation to crucial life events. Finally, we show that membership in the identified donor types predicts long-term donor lapse. Future researchers and blood bank marketeers responsible for recruitment and retention would be advised to take donor heterogeneity into account when studying donors or designing campaigns for recruitment and retention of donors, as not all donors are alike.

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# Appendix A2

## A2.1 Confirmatory factor analysis

We use confirmatory factor analysis (CFA) to assess the reliability of multi-item attitudinal measures and to obtain factor scores of latent variables.

For the panel data set including the DIS-I and DIS-II waves, we first test for longitudinal measurement invariance (LMI) of the attitudinal measures in the panel data set by comparing CFA models assuming configural, metric, and scalar measurement invariance. Validating scalar LMI of the measures used in the classification is important when conducting an LTA to make sure that differences over time are due to changes in means of latent variables rather than changes in the origin of measurement (as reflected in the intercepts), factor loadings, or the factor structure (Mackinnon et al. 2022). Scalar LMI implies that a latent variable is measured by the same items in both periods, that path coefficients of latent variables to their items are equal in both periods, and that intercepts (the means of underlying items) are equal across time points. Appendix Table A2.1 shows a comparison of CFA models assuming configural, metric, and scalar measurement invariance. All CFA models were estimated using full information maximum likelihood, and missing values are therefore treated as missing at random. The fit indices show that the model assuming only configural invariance fits best. However, the change in fit indices used for model comparison (CFI, TLI, AIC, and BIC) between the three models are very small, such that the simpler model should be chosen for parsimony (Cheung and Rensvold 2002; Mackinnon et al. 2022). The Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR) suggest that the model assuming scalar measurement invariance has an overall good fit. Given the importance of scalar LMI for LTA, we use the model specified with scalar LMI for further analysis. Based on this model, we predict factor scores for latent variables using the regression method (Rosseel 2012; Skrondal and Laake 2001), which are used in the LPA and LTA (Johnson 2021; Kam et al. 2016).

Table A2.2 shows the result from the CFA assuming scalar LMI. Composite reliability, as measured by Revelle's omega total (McNeish 2018), is good or acceptable for all factors except for awareness of need, which has a low internal reliability. Because of the conceptual interest in awareness of need and the mainly exploratory nature of this study, we nevertheless include this measure in our classification.

## A2.2 Estimated profiles with two to seven classes

Appendix Figure A2.1 shows the estimated profiles for the solutions with two to seven classes for DIS-I.

**Appendix Table A2.1** Fit comparison of CFA models with different assumptions about longitudinal measurement invariance

| Measure | Configural invariance | Metric invariance | Scalar invariance |
|---|---|---|---|
| Number of parameters | 211 | 191 | 171 |
| CFI | 0.924 | 0.922 | 0.915 |
| TLI | 0.908 | 0.909 | 0.904 |
| $\chi^2$ | 26046.437 | 26711.856 | 29095.997 |
| AIC | 2009710.162 | 2010335.581 | 2012679.722 |
| BIC | 2011399.132 | 2011864.460 | 2014048.508 |
| RMSEA | 0.042 | 0.042 | 0.043 |
| SRMR | 0.033 | 0.038 | 0.040 |

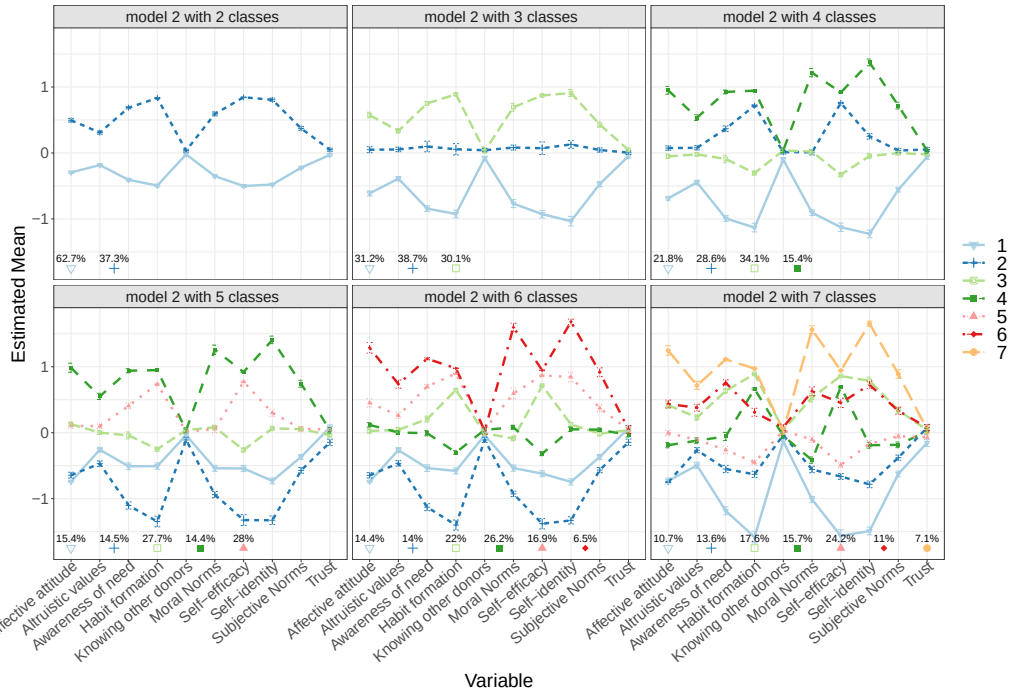
Notes: CFI = comparative fit index, TLI = Tucker Lewis index, $\chi^2$ = chi-squared statistic, AIC = Akaike information criterion, BIC = Bayesian information criterion, RMSEA = root mean square error of approximation, SRMR = standardized root mean square residual.

Appendix Figure A2.2 shows the estimated profiles for the solutions with two to seven classes for DIS-II.

Table A2.3 shows all fit indices for the estimated models from the latent profile analysis of DIS-I and DIS-II participants.

Table A2.3 shows all fit indices for the estimated models from the latent profile analysis of DIS-I participants.

Appendix Figure A2.3 shows the estimated profiles for the solutions with two to seven classes for the entire DIS-I sample instead of only those who participated in both the DIS-I and DIS-II waves of the survey.

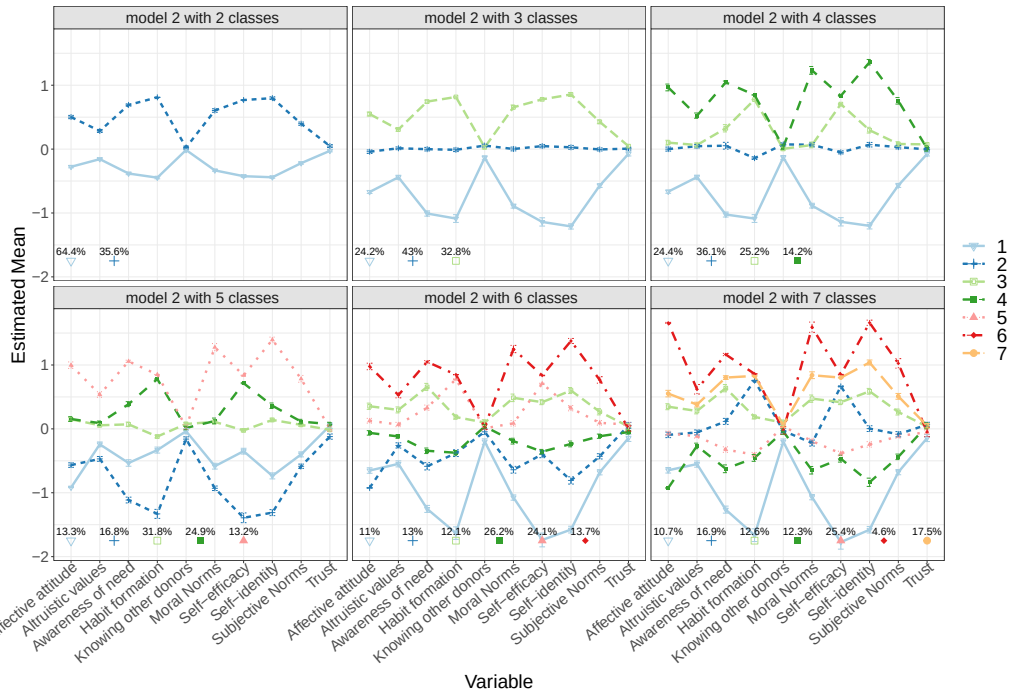



**Appendix Figure A2.1** Profile plot DIS-I: estimated means and 95% confidence intervals of the 10 indicators within each of the two to seven classes.

**Appendix Table A2.2** Results of Confirmatory factor analysis specified with scalar LMI for DIS-I and DIS-II panel sample.

| | DIS-I | | DIS-II | |
|---|---|---|---|---|
| Factor and corresponding items | $\lambda$ | S.E. | $\lambda$ | S.E. |
| **Affective attitudes** ($\omega_{t1}$ = 0.89, $\omega_{t2}$ = 0.86) | | | | |
| 'I find giving blood: | | | | |
| pleasent unpleasent [reverse coded] | 0.773 | 0.004 | 0.813 | 0.004 |
| annoying enjoyable | 0.908 | 0.004 | 0.923 | 0.004 |
| unappealing appealing' | 0.807 | 0.004 | 0.816 | 0.004 |
| **Self-efficacy** ($\omega_{t1}$ = 0.75, $\omega_{t2}$ = 0.79) | | | | |
| 'If I want to, I am capable to keep donating blood/plasma as long as my health allows it.' | 0.740 | 0.006 | 0.773 | 0.006 |
| 'I consider myself capable of continuing to give blood/plasma as long as my health allows it.' | 0.006 | | | |
| **Habit formation** ($\omega_{t1}$ = 0.80, $\omega_{t2}$ = 0.85) | | | | |
| 'When I receive an invitation to give blood, I consider it a matter of course to do so.' | 0.863 | 0.006 | 0.838 | 0.006 |
| 'When I receive an invitation from the blood bank, I automatically go to give blood.' | 0.808 | 0.005 | 0.848 | 0.005 |
| **Moral norms** ($\omega_{t1}$ = 0.74, $\omega_{t2}$ = 0.74) | | | | |
| 'I feel morally obliged to give blood.' | 0.518 | 0.007 | 0.516 | 0.007 |
| 'I would feel guilty if I did not give blood.' | 0.790 | 0.006 | 0.774 | 0.006 |
| 'Not giving blood is actually against my principles.' | 0.767 | 0.006 | 0.756 | 0.006 |
| **Awareness of need** ($\omega_{t1}$ = 0.47, $\omega_{t2}$ = 0.55) | | | | |
| 'My blood is needed' | 0.714 | 0.006 | 0.683 | 0.006 |
| 'I have the feeling that it would not matter if I gave blood.' [reverse coded] | 0.464 | 0.008 | 0.520 | 0.008 |
| **Self-identity** ($\omega_{t1}$ = 0.71, $\omega_{t2}$ = 0.74) | | | | |
| 'I would feel sorry if I could no longer give blood.' | 0.593 | 0.006 | 0.605 | 0.006 |
| 'Being a blood donor is an important part of who I am.' | 0.723 | 0.006 | 0.741 | 0.006 |
| 'Being a blood donor means more to me than just giving blood.' | 0.729 | 0.006 | 0.740 | 0.006 |
| **Altruistic values** ($\omega_{t1}$ = 0.70, $\omega_{t2}$ = 0.71) | | | | |
| 'I prefer to work towards my own wellbeing than towards the wellbeing of others.' [reverse coded] | 0.410 | 0.007 | 0.411 | 0.007 |
| 'I try to work towards the wellbeing of society.' | 0.549 | 0.005 | 0.553 | 0.005 |
| 'I am not very interested in helping others.' [reverse coded] | 0.396 | 0.006 | 0.399 | 0.006 |
| 'It is important to me that I help others.' | 0.728 | 0.005 | 0.723 | 0.005 |
| 'I think it is important to help the poor and the needy.' | 0.735 | 0.006 | 0.729 | 0.006 |

Notes: Abbreviations: $\lambda$ = standardised factor loading; S.E. = standard error; $\omega$ = Revelle's omega total.




**Appendix Figure A2.2** Profile plot DIS-II: estimated means and 95% confidence intervals of the 10 indicators within each of the two to seven classes.

**Appendix Table A2.3** Model fit indices from latent profile analyses of DIS-I and DIS-II participants (N = 22128)

| **DIS-I** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model** | **Classes** | **LL** | **AIC** | **BIC** | **CAIC** | **SABIC** | **ICL** | **Entropy** |
| 1 | 1 | -312970 | 625980.5 | 626140.6 | 626160.6 | 626077.1 | -626141 | 1 |
| 1 | 2 | -291581 | 583224.8 | 583472.9 | 583503.9 | 583374.4 | -585973 | 0.839 |
| 1 | 3 | -283450 | 566984 | 567320.2 | 567362.2 | 567186.7 | -571763 | 0.82 |
| 1 | 4 | -276619 | 553343.2 | 553767.5 | 553820.5 | 553599 | -557882 | 0.867 |
| 1 | 5 | -272429 | 544985.3 | 545497.6 | 545561.6 | 545294.2 | -549587 | 0.886 |
| 1 | 6 | -269879 | 539907.2 | 540507.6 | 540582.6 | 540269.2 | -545635 | 0.872 |
| 1 | 7 | -267140 | 534452.7 | 535141.1 | 535227.1 | 534867.8 | -540979 | 0.865 |
| 2 | 1 | -312970 | 625980.5 | 626140.6 | 626160.6 | 626077.1 | -626141 | 1 |
| 2 | 2 | -273919 | 547921 | 548249.1 | 548290.1 | 548118.8 | -549268 | 0.932 |
| 2 | 3 | -263981 | 528086.4 | 528582.7 | 528644.7 | 528385.6 | -532276 | 0.848 |
| 2 | 4 | -255084 | 510334.6 | 510999 | 511082 | 510735.2 | -514777 | 0.875 |
| 2 | 5 | -250459 | 501126.5 | 501959 | 502063 | 501628.5 | -506331 | 0.873 |
| 2 | 6 | -246492 | 493233.9 | 494234.4 | 494359.4 | 493837.2 | -498923 | 0.875 |
| 2 | 7 | **-243363** | **487018.9** | **488187.6** | **488333.6** | **487723.6** | **-493717** | 0.867 |
| **DIS-II** | | | | | | | | |
| **Model** | **Classes** | **LL** | **AIC** | **BIC** | **CAIC** | **SABIC** | **ICL** | **Entropy** |
| 1 | 1 | -313481 | 627002.2 | 627162.3 | 627182.3 | 627098.7 | -627162 | 1 |
| 1 | 2 | -291538 | 583138.2 | 583386.3 | 583417.3 | 583287.8 | -585863 | 0.839 |
| 1 | 3 | -281162 | 562408.6 | 562744.8 | 562786.8 | 562611.3 | -565981 | 0.868 |
| 1 | 4 | -274061 | 548227.3 | 548651.5 | 548704.5 | 548483.1 | -552909 | 0.862 |
| 1 | 5 | -269044 | 538215.8 | 538728.1 | 538792.1 | 538524.7 | -542867 | 0.884 |
| 1 | 6 | -266481 | 533111.5 | 533711.8 | 533786.8 | 533473.5 | -538773 | 0.87 |
| 1 | 7 | -263977 | 528125.2 | 528813.6 | 528899.6 | 528540.2 | -534651 | 0.865 |
| 2 | 1 | -313481 | 627002.2 | 627162.3 | 627182.3 | 627098.7 | -627162 | 1 |
| 2 | 2 | -270487 | 541056.5 | 541384.7 | 541425.7 | 541254.4 | -542118 | 0.95 |
| 2 | 3 | -257948 | 516020.2 | 516516.4 | 516578.4 | 516319.4 | -519767 | 0.865 |
| 2 | 4 | -249853 | 499871.7 | 500536.1 | 500619.1 | 500272.3 | -503882 | 0.888 |
| 2 | 5 | -244894 | 489995.5 | 490827.9 | 490931.9 | 490497.4 | -494471 | 0.892 |
| 2 | 6 | -241034 | 482318.5 | 483319.1 | 483444.1 | 482921.9 | -487956 | 0.876 |
| 2 | 7 | **-237490** | **475272.6** | **476441.3** | **476587.3** | **475977.3** | **-481439** | 0.879 |

Notes: Bold = best fit statistic for each individual statistic. Abbreviations: LL = model log likelihood, AIC = Akaike information criterion, BIC = Bayesian information criterion, CAIC = consistent Akaike information Criterion, SABIC = sample size adjusted Bayesian information criterion, ICL = Integrated consistent likelihood, Entropy = relative entropy.

**Appendix Table A2.4** Model fit indices from latent profile analyses of DIS-I participants (N = 31336)

| Model | Classes | LL | AIC | BIC | CAIC | SABIC | ICL | Entropy |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | -442891 | 885822.2 | 885989.3 | 886009.3 | 885925.7 | -885989 | 1 |
| 1 | 2 | -410738 | 821538.9 | 821797.8 | 821828.8 | 821699.3 | -825300 | 0.841 |
| 1 | 3 | -397472 | 795027.1 | 795377.9 | 795419.9 | 795244.4 | -800676 | 0.847 |
| 1 | 4 | -388004 | 776114 | 776556.7 | 776609.7 | 776388.2 | -782246 | 0.869 |
| 1 | 5 | -382101 | 764330 | 764864.5 | 764928.5 | 764661.1 | -770517 | 0.889 |
| 1 | 6 | -378273 | 756697 | 757323.4 | 757398.4 | 757085.1 | -764542 | 0.87 |
| 1 | 7 | -374156 | 748484.5 | 749202.8 | 749288.8 | 748929.5 | -757352 | 0.867 |
| 2 | 1 | -442891 | 885822.2 | 885989.3 | 886009.3 | 885925.7 | -885989 | 1 |
| 2 | 2 | -386131 | 772343.6 | 772686 | 772727 | 772555.7 | -773766 | 0.949 |
| 2 | 3 | -367386 | 734896.9 | 735414.8 | 735476.8 | 735217.7 | -740054 | 0.866 |
| 2 | 4 | -352421 | 705007.6 | 705700.9 | 705783.9 | 705437.1 | -710014 | 0.9 |
| 2 | 5 | -341464 | 683136.7 | 684005.4 | 684109.4 | 683674.8 | -688445 | 0.908 |
| 2 | 6 | -334142 | 668534.6 | 669578.7 | 669703.7 | 669181.4 | -673987 | 0.917 |
| 2 | 7 | **-326297** | **652885.9** | **654105.4** | **654251.4** | **653641.4** | **-658919** | 0.916 |

Notes: Bold = best fit statistic for each individual statistic. Abbreviations: LL = model log likelihood, AIC = Akaike information criterion, BIC = Bayesian information criterion, CAIC = consistent Akaike information Criterion, SABIC = sample size adjusted Bayesian information criterion, ICL = Integrated consistent likelihood, Entropy = relative entropy.


**Appendix Figure A2.3** Profile plot for complete DIS-I sample: estimated means and 95% confidence intervals of the 10 indicators within each of the two to seven classes.

# Chapter 3

# The social contagion of prosocial behaviour: How neighbourhood blood donations influence individual donation behaviour

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## Abstract

Life-saving transfusions and numerous other medical treatments are enabled by a minority of people that donate blood. But why do some people repeatedly engage in such prosocial behaviour, especially when it is costly to themselves? This study examines to what extent social contagion within neighbourhoods – changing behaviour in response to the behaviour of others – affects repeated blood donation behaviour. We draw on longitudinal survey and register data from a representative sample of blood donors in the Netherlands from 2007 to 2014 (N=15090). Using a panel data model and an instrumental variable approach, we find that donors are positively affected by donations made by other donors living in their neighbourhood. This effect does not seem to be mediated by normative or informational social influence. Exploratory analysis further attributes this finding to social contagion within donor couples. Our study contributes to the literature on repeated blood donation behaviour, and can inform retention strategies of blood banks.

## 3.1 Introduction

Blood donations save lives by enabling transfusions and numerous other routine medical treatments (Healy 2000; Slonim et al. 2014). For donors, however, they are costly in terms of time and potential inconveniences. Because of that, blood donations are often considered an ideal-typical example of prosocial behaviour. In many countries, blood donors make up less than five percent of the age-eligible population, and the majority of donations therefore come from few people that continuously donate over the course of their life (Masser et al. 2008; Piersma et al. 2017; Piersma et al. 2019; Piliavin 1990)[1].

Why do some people repeatedly engage in prosocial behaviour even when this behaviour is costly to themselves? Two strands of literature have made important progress towards answering this question.

First, studies aiming to explain real-world (i.e., non-experimental) prosocial behaviour provide a comprehensive picture of individual-level determinants of repeated prosocial behaviour, such as resources (Wilson and Musick 1997) and the development of a role-identity (Piliavin et al. 2002). With few exceptions (e.g., Cimaroli et al. (2012), Merz et al. (2017), and Piersma et al. (2021)), however, most of these studies are individual-centred and do not account for the physical or social context of behaviour (Bekkers and Wiepking 2011; Irwin and Simpson 2013; Piersma et al. 2017).

A second strand of the literature has focused on contextual conditions that allow prosocial behaviour to be sustained over time, and has so far mainly drawn on laboratory experiments. These studies of collective action have demonstrated the importance of the social context for prosocial behaviour to persist over time (Simpson and Willer 2015). For example, prosocial behaviour can be sustained over time if social norms can be enforced through rewards and punishments. Another key result has been that individuals keep contributing to public goods if they believe that others do so as well, and reduce their contribution if they believe others will no longer contribute (Chaudhuri 2011; Thöni and Volk 2018). This is evidence for social contagion, broadly defined as a process where individuals change their behaviour in response to the behaviour of others[2]. Social contagion of prosocial behaviour can be both a blessing and a curse: donors might be encouraged to keep donating as long as others do as well, but might also reduce their contributions because they perceive that others do not contribute. Many health behaviours have been shown to be affected by social contagion, ranging from smoking and health screenings to suicidality (Christakis and

[1] Systems for collecting blood are diverse. Countries in the Global North (including the Netherlands) largely rely on voluntary and non-remunerated donations where donor and recipient remain anonymous to each other. Countries in the Global South more frequently rely on remunerated donations and sometimes on family-replacement systems (Slonim et al. 2014). See Healy (2000) for a discussion of how the proportion of blood donors in the population is affected by countries' collection regimes.

[2] Related terms in adjacent literature are conditional cooperation, peer effects, social influence, or third-party influence.

Fowler 2013; Haas and Schaefer 2014; Mueller and Abrutyn 2015). However, despite the accumulating evidence for the social contagion of prosocial behaviour from experimental studies, it remains unclear to what extent social contagion affects real-world prosocial behaviour and blood donation in particular.

The limited attention to social contagion might be a crucial oversight given the insights into its importance from studies of collective action. At the same time, many theoretical models underlying studies of real-world prosocial behaviour have developed individual-level measures for individuals exposure to social influences. The Theory of Planned Behaviour (TPB) (Ajzen 1991), which has been the dominant theoretical basis for empirical studies explaining blood donation behaviour (Masser et al. 2020), predicts that all contextual influences are mediated by individuals attitudes and intentions (Sniehotta et al. 2014). The concepts developed within the TPB framework and its extensions can therefore be useful to assess *how* social contagion might affect prosocial behaviour.

In this study, we link insights from both strands of the literature: studies taking an individual-centred approach to the analysis of repeated real-world prosocial behaviour and studies with a focus on the social context of prosocial behaviour. Our first goal is to assess to what extent social contagion influences repeated blood donations. The second goal is to test potential underlying mechanisms of social contagion, such as normative or informational social influence (Deutsch and Gerard 1955; White et al. 2009). In the following, we review the relevant literature and derive hypotheses about the social contagion of blood donations.

Social contagion of repeated blood donations implies that individuals change their donation behaviour according to the donation behaviour of others. But who might be relevant others? In laboratory experiments on social contagion, individuals are typically assigned to small artificial groups composed of a few other individuals whose behaviour is directly observable (Thöni and Volk 2018). In the real world, however, social influences operate through social networks and social relations (Christakis and Fowler 2013; Ruppel et al. 2022). It is therefore the *social environment* that is of importance for social contagion to work. A large literature on neighbourhood effects has shown that neighbourhoods, particularly smaller scale geographical areas, are relevant social contexts for behaviour (Galster 2012; Petrovi et al. 2019; Pinkster and Völker 2009). For the Netherlands, it has also been shown that small scale administrative areas can capture neighbourhood effects (E. M. Veldhuizen et al. 2013). To test the implications of laboratory experiments on social contagion for real-world prosocial behaviour, an obvious choice to capture the social environment is therefore the neighbourhood. At the same time, not all of individuals' social networks map into neighbourhoods. For example, Völker et al. (2007) have shown that among people drawn from a representative sample of neighbourhoods in the Netherlands, about 20% of the members of a social network were also neighbours. The local orientation of social networks also varies by ethnic background and socio-economic status (Pinkster and Völker 2009). In addition, certain types of social relations are more likely to be observed within

neighbourhoods. For example, family members are more likely to live in the same neighbourhood than friends or colleagues.

Furthermore, it has been shown that the strength of social contagion of prosocial behaviour increases with social proximity (Dimant 2019). From the domain of charitable giving, there is evidence that married couples often make joint decisions about whether and how much to donate to charity through 'cooperative bargaining' (Andreoni et al. 2003; Einolf et al. 2018; Mesch et al. 2022; Yörük 2010). Blood donations are ultimately individual contributions, but it is likely that decisions about whether and how often to donate are nevertheless coordinated with close social contacts. Given that family members and especially partners have a higher (compared to other social contacts) likelihood to live in the same neighbourhood and a high social proximity to the focal individual, we might expect them to be among the stronger sources of social influence within neighbourhoods – a question that we will return to in our exploratory analysis.

The only existing empirical evidence for social contagion among blood donors that we are aware of comes from Bruhin et al. (2020), who show that invitations to donate blood sent to pairs of donors living at the same address (many likely to be couples) are about 70% more effective in soliciting donations than invitations sent to isolated donors. However, it is unclear to what extent social contagion influences *repeated* blood donation, and whether social contagion extends to the broader social context of neighbourhoods. Drawing on the comprehensive theoretical and empirical work on social contagion in prosocial behaviour, we hypothesise:

*Hypothesis 1: The higher the number of blood donations by others, the higher the individual's number of blood donations.*

Hypothesis 1 is at the core of our theoretical framework depicted in Figure 3.1. To tackle the question through which psychological mechanisms social contagion might work, we conceptualise potential mechanisms along the lines of two distinct forms of social influence, namely normative and informational social influence (Deutsch and Gerard 1955; Frey and Meier 2004; van Teunenbroek et al. 2020).

### 3.1.1 Normative social influence

Normative social influence can be defined as 'an influence to conform with the positive expectations of another' (Deutsch and Gerard 1955, p. 629). Below, we argue that donations by others can create such expectations through three channels: influence on subjective norms about blood donation, influence on the likelihood of forming an identity as a blood donor, and influence on moral norms about blood donations.

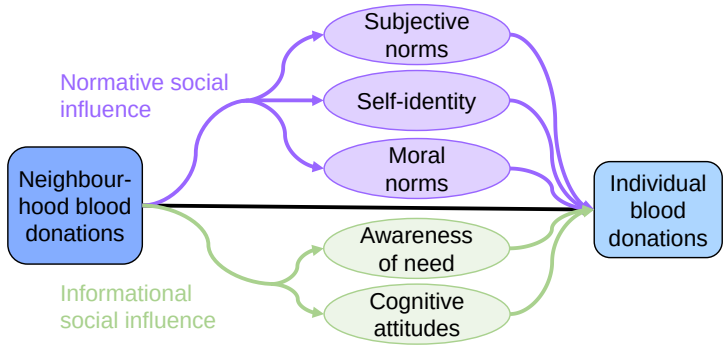


**Figure 3.1** Theoretical model of mechanisms underlying social contagion of blood donations.

### Subjective norms

Subjective norms reflect to what extent individuals believe that others expect them to show a specific behaviour (Ajzen 1991). While there is ample evidence that subjective norms about blood donations affect individuals' blood donation behaviour (Bednall et al. 2013), it is unclear how subjective norms about blood donation are formed and related to others' donation behaviour. Suggestive evidence for such a relationship comes from White et al. 2009, who show that subjective norms for recycling behaviour are related to perceptions about recycling behaviour of others. Thus, we expect that subjective norms about blood donations are also derived from others *actual* donation behaviour. We hypothesise that:

*Hypothesis 2: The positive effect of donations by others on individual blood donations is mediated by individuals' subjective norms about blood donations.*

### Self-identity

Sociological and social psychological theory emphasise social self-identities next to individual identities (Stryker and Burke 2000; Turner 1978). Theoretical accounts argue that a self-identity emerges as others identify an individual with a specific role (Charng et al. 1988; Grube and Piliavin 2000; Turner 1978), and made salient in contexts where social relations are tied to this self-identity (Charng et al. 1988; Stryker and Burke 2000). These processes of group and role identification are more likely to take place in social contexts where other people are actively engaged in blood donation behaviour (Charng et al. 1988; Irwin and Simpson 2013; Piliavin 1990). Self-identity as a blood donor, in turn, is an important predictor of repeated blood donations (Bednall et al. 2013; Masser et al. 2008). We therefore hypothesise that:

*Hypothesis 3: The positive effect of the donations by others on individual blood donations is mediated by individuals' self-identity as a blood donor.*

#### Moral norms

Moral norms can be understood as the internalisation of social norms (Armitage and Conner 2001; Gintis et al. 2003). Moral norms for behaviour can be constructed in a specific context, activated for example by receiving a request (Piliavin and Libby 1986). In addition, Lindström et al. (2018) have shown that individuals perceive prosocial behaviour as more morally obligatory the more commonly they observe it. Being among other active blood donors might therefore increase individuals' moral norms about blood donations. In turn, because the violation of moral norms incurs costs, e.g., in the form of guilt, higher moral norms about prosocial behaviour should increase repeated prosocial behaviour (Gintis et al. 2003). This has also been shown for the case of blood donations (Masser et al. 2008). We hypothesise that:

*Hypothesis 4: The positive effect of donations by others on individual blood donations is mediated by individuals' moral norms about blood donations.*

### 3.1.2 Informational social influence

Informational social influence happens when one accepts 'information obtained from another as evidence about reality' (Deutsch and Gerard 1955, p. 629), which can lead to attitude change (Wood 2000). Below, we outline that awareness of need for blood donations and cognitive attitudes about blood donations might be derived from the donation behaviour of others, and in turn affect blood donation behaviour.

#### Awareness of need

Awareness of need has been identified as central factor motivating charitable giving (Bekkers and Wiepking 2011; van Teunenbroek et al. 2020), and awareness of need for blood donations is among the most frequently self-reported motivations for donating blood (Ferguson et al. 2020). Theoretically, the effect of donations by others on an individual's awareness of need might be positive or negative. A positive relationship follows from the assumption that donations by others make the need for prosocial behaviour apparent in the first place (Schervish and Havens 1997). A negative relationship follows from models of pure altruism (Becker 1974), impure altruism (Andreoni 1990), and diffusion of responsibility (Darley and Latane 1968), where own and others' contributions are largely seen as substitutes in

addressing a given need. Tsvetkova and Macy (2014) have linked these two perspectives by showing that contributions by others initially increase own contributions, and decrease own contributions once they are fairly common. Because only a small proportion of adults in the Netherlands donate blood, donations by others should increase rather than decrease awareness of need for blood donations. We therefore hypothesise that:

*Hypothesis 5: The positive effect of donations by others on individual blood donations is mediated by individuals' awareness of need for blood donations.*

**Cognitive attitudes**

Cognitive attitudes refer to 'the degree to which a person has a favorable or unfavorable appraisal of the behavior in question' (Ajzen 1991, p. 188). Several studies have shown that cognitive attitudes about blood donation positively affect the donation behaviour of current donors (Bednall et al. 2013). According to the TPB, cognitive attitudes are determined by expectations about the outcome of performing the behaviour (Ajzen 1991). These expectations might be impacted by the prosocial behaviour of others, e.g., whether performing the behaviour is seen as something positive or worthwhile. For example, the donation behaviour of others might be perceived as a 'quality signal' for the cause of blood donations, indicating that a cause is worth enduring personally costly behaviour, or less costly than initially thought (Frey and Meier 2004; van Teunenbroek et al. 2020). We hypothesise that:

*Hypothesis 6: The positive effect of the donations of others on individual blood donations is mediated by individuals' cognitive attitudes about blood donations.*

## 3.2 Data and methods

Our two main data sources are the Donor InSight study (DIS; see Timmer et al. (2019) for information on collection procedures) and the Dutch Donor Registry (Sanquin 2020). DIS is a longitudinal survey among a representative sample of the Dutch blood donor population in 2007-2009 (DIS-I, N=31338) and 2012-2013 (DIS-II, N=34826, of whom 22132 (63.6%) also participated in DIS-I). The Dutch Donor Registry contains routinely collected data on individuals' blood donations, invitations to donate, donor addresses, and demographics. Sanquin is the only organisation that collects blood in the Netherlands. The Dutch Donor Registry therefore provides complete data on all blood donations within the study period, regardless of whether an individual participated in DIS or not.

### 3.2.1 Sample

22132 individuals participated in both DIS waves. To focus on donors, we exclude 2983 participants who never made a donation since 2007. We further exclude 1645 participants (7%) who donate blood plasma (with a much higher possible donation frequency) instead of whole blood, 1281 participants (6%) who started donating after the start of the study period in 2007, and 1133 participants (5%) who were too old to donate (older than 70). Our analyses thus draw on a sample of 15090 blood donors observed in both 2007-2009 and 2012-2014.

### 3.2.2 Variables

Table 3.1 provides descriptive statistics for the study variables. Appendix Table A3.1 shows a correlation matrix of study variables. Below, we describe the central study measures in more detail.

#### Whole blood donation attempts

Our dependent variable (DV) is the individual's number of whole blood donation attempts in 2007-2009 and in 2012-2014, as registered in the Donor Registry[3]. The number of donation attempts provides a measure of *repeated* prosocial behaviour within each period. Aggregating the behavioural data for these three-year periods further keeps the behavioural measure of prosocial behaviour closely related to the socio-demographic and attitudinal measures obtained through the survey. Figure 3.2 shows a histogram of the number of whole blood donation attempts in the two periods (2007-2009 and 2012-2014). On average, donors made 3.93 donations in the first and 3.23 donations in the second period. The most notable difference is that the proportion of people making no donation attempt increased from about 24% in the first period to about 35% in the second period.

[3]Compared to successful donations, donation attempts better capture individuals' prosocial behaviour, that is, presenting at the blood bank to make a donation, irrespective of cases where donors had to be deferred from making a donation for medical reasons.

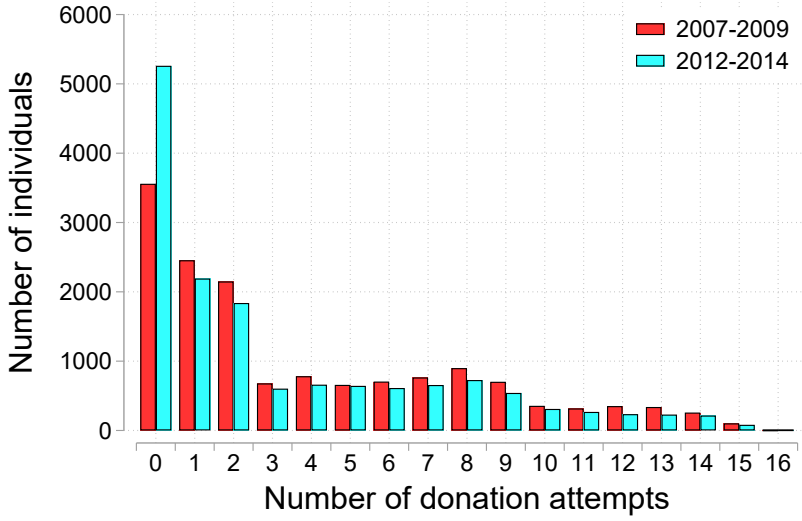


**Figure 3.2** Histogram of the count of the individuals' whole blood donation attempts in 2007-2009 and 2012-2014, N = 15090.

### Donation attempts per inhabitant

To capture the donation behaviour of other donors in the neighbourhood, we use the number of other donors' donation attempts per inhabitant within the focal donor's six-digit postcode. Importantly, this measure does therefore not include the number of donation attempts by the focal donor themself. The six-digit postcodes of the Netherlands are small-scale geographical units that were originally derived from walking routes of postmen. There are approximately 430000 postcodes, and the ones in our sample have an average of 58 inhabitants (Median = 50, Min = 5, Max = 1240). The number of inhabitants per six-digit postcode is provided by Statistics Netherlands (Centraal Bureau voor de Statistiek (CBS) 2020). We use the number of inhabitants on 1 January 2010 to create the variable for the first period, and the number of inhabitants on 1 January 2014 for the second period.

### Mediators

The measures of subjective norms about blood donation, self-identity as a blood donor, and moral norms about blood donation are based on scales commonly used in (extensions of) the TPB (Ajzen 1991), adapted to the blood donation context in previous work (Charng et al. 1988; Merz et al. 2017; I. Veldhuizen et al. 2011). They were measured using a five-point Likert scale ranging from 'completely disagree' to 'completely agree'. Table 3.2 shows the items used to measure these constructs. Item 1 of subjective norms additionally

**Table 3.1** Summary statistics of study measures.

| | Mean or % | Min | Max | SD | SD betw. | SD within |
|---|---|---|---|---|---|---|
| Individuals' donation attempts | 3.58 | 0.00 | 16.00 | 3.99 | 3.67 | 1.56 |
| Donation attempts per inhabitant | 0.10 | 0.00 | 3.00 | 0.15 | 0.13 | 0.07 |
| Invitations to donate per inhabitant | 0.23 | 0.00 | 3.80 | 0.29 | 0.26 | 0.14 |
| Male | 45.10 % | 0.00 | 1.00 | | | |
| Income | 3.83 | 1.00 | 7.00 | 1.57 | 1.57 | 0.00 |
| Age | 48.29 | 19.59 | 68.50 | 11.44 | 11.26 | 2.00 |
| Working hours | 26.71 | 0.00 | 95.00 | 15.62 | 14.55 | 6.13 |
| ln(working hours+1) | 2.85 | 0.00 | 4.56 | 1.35 | 1.25 | 0.56 |
| Having children | 76.20 % | 0.00 | 1.00 | | | |
| Individuals' invitations to donate | 7.25 | 0.00 | 35.00 | 6.62 | 5.96 | 2.88 |
| ln(Individuals' invitations +1) | 1.62 | 0.00 | 3.58 | 1.12 | 1.01 | 0.48 |
| Previous donations | 28.89 | 0.00 | 147.65 | 22.28 | 22.28 | 0.00 |
| Permanently deferred | 7.40 % | 0.00 | 1.00 | | | |
| Subjective norms | 0.00 | −1.94 | 1.87 | 0.88 | 0.82 | 0.33 |
| Self-identity | 0.00 | −3.72 | 2.27 | 0.93 | 0.88 | 0.30 |
| Moral norms | 0.00 | −2.22 | 2.19 | 0.90 | 0.86 | 0.29 |
| Awareness of need | 0.01 | −4.84 | 1.15 | 0.81 | 0.76 | 0.28 |
| Cognitive attitudes | 0.00 | −7.69 | 0.84 | 0.79 | 0.69 | 0.38 |
| Generalized social trust | 0.00 | −3.79 | 2.51 | 0.85 | 0.85 | 0.07 |
| Altruism | 0.00 | −3.95 | 2.11 | 0.88 | 0.83 | 0.30 |
| Self-efficacy | 0.00 | −5.37 | 1.03 | 0.95 | 0.80 | 0.50 |
| Affective attitudes | 0.00 | −3.34 | 1.86 | 0.94 | 0.86 | 0.37 |

Abbreviations: SD betw. = standard deviation of variable between individuals. SD within = standard deviation of variable within individuals over time. Descriptive statistics for attitudinal measures (Subjective norms - Affective attitudes) are predicted factors scores based on the measurement model (see Table 3.2). For these measures, higher values indicate more of the measured construct.

included does not apply, I do not have a partner' as a response option, which was recoded to 1 (completely disagree), to reflect that these individuals are not subject to influence by partners. To measure awareness of need for blood donations, we use responses to the two questions given in Table 3.2, also measured on a five-point Likert-type scale. Cognitive attitudes towards blood donation were elicited using a semantic-differential scale, where respondents fill out a five-point rating option based on the bipolar adjective pairs given in Table 3.2.

### Covariates

Our models include donor age in years, sex (0 = female, 1 = male), having children (0 = no, 1 = yes), working hours per week, monthly net income in seven categories, overall number of blood donations before 2007, being permanently deferred (0 = no, 1 = yes), donation invitations, generalised social trust (GST), altruistic values, self-efficacy, and affective attitudes towards blood donation as covariates. These variables have been found to affect blood do-

nation behaviour (Bednall et al. 2013; Merz et al. 2017; Piersma et al. 2017; Piersma et al. 2019), and might be confounders of the relationship between own and others donations if they also affect others' blood donation behaviour, for example because of homophily in social relations. The number of donation invitations and individuals' working hours were log-transformed to better meet the linearity assumption of the Poisson model described below (see Appendix section A3.4). Details of the measurement of attitudinal variables can be found in Table 3.2, and details on the measurement of the remaining covariates are given in the study's preregistration available at https://osf.io/wjyvg.

### 3.2.3 Methods

There are two main concerns of endogeneity when estimating the effect of others' donations on the focal individual's donations. The first is that the donations by others might be correlated with unobserved time-constant heterogeneity between donors that also affects their donation behaviour. To address this concern, we use a correlated random effects (CRE) panel data model, which controls for time-constant unobserved heterogeneity between donors. The second concern is that changes in donations by others over time are correlated with time-varying unobserved factors, for example external shocks like closing or opening of specific donation locations. To address this concern, we use a CRE instrumental variable (IV) approach that simultaneously addresses potential endogeneity with regard to time-constant and time-varying unobservables (Lin and Wooldridge 2019). Both approaches are described in more detail in the section 'structural model'.

We implement these approaches in a structural equation modelling (SEM) framework. A SEM consists of two major components: a measurement model and a structural model. The measurement model describes how latent constructs, such self-identity as a blood donor, are related to the observed survey items. The structural model describes the relationships between the variables, as predicted by hypotheses 1-6. We first estimate the measurement model using full information maximum likelihood, and subsequently include the predicted factor scores of the latent variables in the structural model[4].

We preregistered our hypotheses, the operationalisation of variables, and an analysis plan through the Open Science Framework: https://osf.io/wjyvg. We depart from the preregistered analysis plan in two ways. First, we additionally include permanent deferral from donating blood as covariate. This slightly increases precision but does not change the results substantially. Second, we do not rerun our analyses with donations by others aggregated based on four-digit postcodes. These are much larger in size and, as our results will demonstrate, are therefore unlikely to accurately capture the donation behaviour of relevant others.

[4]This is to avoid numerical integration across many dimensions, which is required in maximum likelihood estimation of a nonlinear model including continuous latent variables and would make the estimation duration unfeasible and the results potentially inaccurate (Rockwood 2021).

Statistical analyses are carried out in Stata 16 (StataCorp. 2019). The models are estimated using quasi-maximum likelihood estimation (QMLE) to obtain standard errors that are robust to heteroskedasticity (e.g., violations of the Poisson models' assumption of equidispersion, which is further examined in Appendix section A3.4) (Cameron and Trivedi 2013; StataCorp. 2016; Wooldridge 2013).

**Measurement model**

In the measurement model, the survey items that make up latent constructs are included in a confirmatory factor analysis (CFA). We assume scalar longitudinal measurement invariance, meaning that the psychometric properties of constructs do not change with repeated measurements. Latent variables are therefore measured by the same items in both periods, and intercepts and path coefficients of the measurement model are constrained to be equal in both waves (Baldwin 2019). Results of the CFA are displayed in Table 3.2. All indicators load significantly on the latent constructs. The composite reliability estimates (CR) suggest that convergent validity of most constructs is acceptable, with estimates being around or above 0.7. The measures of awareness of need, cognitive attitudes, and GST, however, have worse convergent validity, as indicated by composite reliability estimates of around 0.55, which is below the commonly suggested threshold of 0.6 (Bagozzi and Yi 1988). To stick to commonly used scales and our preregistered analysis plan, we do not respecify the CFA based on composite reliability. Regarding discriminant validity, we observe that correlations between predicted factor scores are at most moderate in size (see Appendix Table A3.1), suggesting reasonable discriminant validity between constructs (Kline 2016). Two exceptions are strong correlations of self-identity with moral norms (r = 0.76) and self-efficacy (r = 0.70), indicating that these constructs measure similar concepts. We discuss their potentially interrelated impact on donation behaviour below.

**Table 3.2** Confirmatory factor analysis of attitudinal measures.

| | Period 1 | | Period 2 | |
|---|---|---|---|---|
| | $\lambda$ | S.E. | $\lambda$ | S.E. |
| **Subjective norms ($CR_{t1}$ = 0.708, $CR_{t2}$ = 0.706)** | | | | |
| 'My partner thinks I should continue giving blood as long as my health allows it.' | 0.631 | 0.006 | 0.644 | 0.006 |
| 'My family and friends think that I should continue giving blood as long as my health allows it.' | 0.841 | 0.007 | 0.828 | 0.007 |
| **Self-identity ($CR_{t1}$ = 0.688, $CR_{t2}$ = 0.699)** | | | | |
| 'Being a blood/plasma donor is an important part of who I am.' | 0.686 | 0.005 | 0.699 | 0.005 |
| 'Being a blood donor means more to me than just giving blood.' | 0.638 | 0.005 | 0.648 | 0.005 |
| 'I would feel sorry if I could no longer give blood.' | 0.629 | 0.004 | 0.633 | 0.005 |
| **Moral norms ($CR_{t1}$ = 0.735, $CR_{t2}$ = 0.723)** | | | | |
| 'I feel morally obliged to give blood.' | 0.514 | 0.005 | 0.511 | 0.005 |
| 'I would feel guilty if I did not give blood.' | 0.791 | 0.004 | 0.775 | 0.004 |
| 'Not giving blood is actually against my principles.' | 0.759 | 0.004 | 0.747 | 0.004 |
| **Awareness of need ($CR_{t1}$ = 0.525, $CR_{t2}$ = 0.535)** | | | | |
| 'My blood is needed.' | 0.728 | 0.008 | 0.695 | 0.008 |
| 'I have the feeling that it would not matter if I gave blood.' [reverse coded] | 0.454 | 0.007 | 0.508 | 0.007 |
| **Cognitive attitudes ($CR_{t1}$ = 0.548, $CR_{t2}$ = 0.585)** | | | | |
| 'I find giving blood ... | | | | |
| negative – positive | 0.647 | 0.008 | 0.617 | 0.007 |
| good – bad [reverse coded] | 0.432 | 0.007 | 0.536 | 0.007 |
| meaningless – worthwhile.' | 0.525 | 0.007 | 0.543 | 0.007 |
| **Generalized social trust ($CR_{t1}$ = 0.523, $CR_{t2}$ = 0.528)** | | | | |
| 'In general, most people can be trusted.' | 0.566 | 0.007 | 0.578 | 0.007 |
| 'You can not be careful enough when you are dealing with other people.' [reverse coded] | 0.624 | 0.007 | 0.620 | 0.007 |
| **Altruistic values ($CR_{t1}$ = 0.709, $CR_{t2}$ = 0.711)** | | | | |
| 'Id rather work for my own well being than for that of others' [reverse coded] | 0.433 | 0.006 | 0.431 | 0.006 |
| 'I try to work towards the wellbeing of society.' | 0.549 | 0.005 | 0.555 | 0.005 |
| 'I am not very interested in helping others' [reverse coded] | 0.417 | 0.006 | 0.424 | 0.006 |
| 'It is important to me that I help others.' | 0.720 | 0.005 | 0.719 | 0.005 |
| 'I think it is important to help the poor and the needy.' | 0.719 | 0.005 | 0.716 | 0.005 |
| **Self-efficacy ($CR_{t1}$ = 0.899, $CR_{t2}$ = 0.872)** | | | | |
| 'If I wanted to, I would be able to continue giving blood as long as my health allows it.' | 0.727 | 0.004 | 0.763 | 0.004 |
| 'When I receive an invitation to give blood, I consider it a matter of course to do so.' | 0.715 | 0.004 | 0.677 | 0.004 |
| 'I am planning to continue giving blood as long as my health allows it.' | 0.858 | 0.002 | 0.800 | 0.003 |
| 'I will continue to be a blood donor until it is no longer possible for me to donate.' | 0.834 | 0.003 | 0.664 | 0.004 |
| 'When I receive an invitation from the blood bank, I automatically go to give blood.' | 0.639 | 0.004 | 0.654 | 0.004 |
| 'I think that I will continue to give blood as long as my health permits it.' | 0.846 | 0.002 | 0.809 | 0.003 |
| **Affective attitudes ($CR_{t1}$ = 0.868, $CR_{t2}$ = 0.883)** | | | | |
| 'I find giving blood ... | | | | |
| pleasant – unpleasant [reverse coded] | 0.775 | 0.003 | 0.809 | 0.003 |
| annoying – enjoyable | 0.907 | 0.002 | 0.920 | 0.002 |
| unappealing – appealing.' | 0.799 | 0.003 | 0.805 | 0.003 |

Abbreviations: $\lambda$ = standardized factor loading; S.E. = standard error; CR = composite reliability estimate.
RMSEA = 0.046; CFI = 0.851; TLI = 0.836.

**Structural model**

Using longitudinal data provides the opportunity to account for unobserved time-invariant heterogeneity between individuals. We use a CRE Poisson regression for modelling the count of an individual's blood donation attempts in the two periods from 2007-2009 and 2012-2014. The CRE model introduces an unobserved individual effect $a_i$ to the panel data Poisson model

$$E[y_{it}|x_{it}, a_i] = a_i \, exp(\beta x_{it}), \tag{3.1}$$

where $y_{it}$ denotes the outcome variable for person $i$ at time $t$, $x_{it}$ are the time-varying predictors with coefficients $\beta$, and $a_i$ is the unobserved effect. The random effects (RE) assumption is that $a_i$ is uncorrelated with the predictors $x_{it}$. If this assumption is not met, the time-varying predictors $x_{it}$ are endogenous because of omitted variables that are captured by $a_i$ and correlated with the time-varying predictors $x_{it}$, leading to a biased estimation of $\beta$ (Hamaker and Muthén 2020; Wooldridge 2013). This assumption can be tested by including time-averaged values of time-varying predictors $\overline{x}_i$ to model the correlation between $a_i$ and $x_{it}$. Assuming a linear relationship, $a_i$ is modelled as

$$a_i = exp(\gamma \overline{x}_i + r_i), \tag{3.2}$$

where $\overline{x}_i$ is the time average of the time-varying variables with coefficients $\gamma$ and $r_i$ denotes unobserved heterogeneity that is assumed to be uncorrelated with $x_{it}$ (Cameron and Trivedi 2013). Substituting equation 3.2 into equation 3.1 gives

$$E[y_{it}|x_{it}, a_i] = exp(\beta x_{it} + \gamma \overline{x}_i + r_i), \tag{3.3}$$

which is the CRE Poisson model (Cameron and Trivedi 2013). The estimate for $\gamma$, called the 'contextual effect', serves as tool for testing whether CRE or RE assumptions are necessary. An estimate of a contextual effect that is not statistically significantly different from zero means that the RE assumption is sufficient. In that case the RE approach delivers more efficient estimates of $\beta$ (Wooldridge 2013). We thus include the statistically significant contextual effects into our models (Schunck and Perales 2017).

We first estimate a model with socio-demographic variables as controls (Model 1 in Table 3.3). In the second model, we include the mediators in the regression of individuals donation attempts on donation attempts per inhabitant (Model 2 in Table 3.3). In the third model, we include attitudinal covariates which might be confounders regarding the mediators and individual's donation attempts (Model 3 in Table 3.3). Model 3 also includes the estimates for how the mediators are affected by the donation attempts per inhabitant. For analysis of the indirect effects we use the product method and obtain standard errors via the delta method (Coxe and MacKinnon 2010).

**Instrumental variable approach**

We use an instrumental variable approach to address the concerns of endogeneity with regard to time-varying unobservables. In the Netherlands, the vast majority of blood donations are made following a personal invitation from the blood bank. We use the number of invitations to donate blood per other inhabitant as an instrument for the donation attempts per other inhabitant. This instrument should meet the relevance and exogeneity requirements of an appropriate instrumental variable: it is strongly related to the donation behaviour of others, but, conditional on covariates (e.g., the individuals' invitations to donate), not directly related to the individuals' blood donation behaviour. It should therefore affect the individual's donations only through its effect on the donations by others. One caveat to the exogeneity of the instrument might be that donors could receive invitations addressed to someone else living in the same household. However, invitations are personal and we therefore consider it unlikely that an individual donates based on the invitation to someone else. Invitations per inhabitant is calculated in a way analogous to the number of donation attempts per inhabitant, based on data from the Donor Registry. To implement the instrumental variable approach in the CRE Poisson model, we follow the two-step control function approach described in Lin and Wooldridge (2019). In the first step, the donations by others are regressed on the number of invitations to others and covariates in a fixed-effects regression. In the second step, we re-estimate Model 3 described above while including the residuals from the first step (the control function), and obtain standard errors via bootstrapping based on 5000 replications (Cameron & Trivedi, 2013, p. 56; Lin & Wooldridge, 2019).

## 3.3 Results

We first present results on social contagion of blood donation behaviour, and exploratory analyses on the question through which social relations social contagion within neighbourhoods occurs. We then present results on the potential mediating mechanisms underlying social contagion.

### 3.3.1 Social contagion influences repeated blood donations

Hypothesis 1 stated that individuals increase or decrease their donations in line with the donations made by others. From Model 1 in Table 3.3 we see that a one-unit increase in the number of donations per inhabitant is estimated to increase the number of an individual's donations by about 11% ($b = 0.108, p = 0.013$). This estimate does not substantially change after including the potential mediators (Model 2) and further covariates (Model 3). The left-hand panel of Figure 3.3 visualises this effect. It indicates that an increase in the

donation attempts per inhabitant from 0 to 1 would increase the individual's donations from about 3.2 donations to about 3.5 donations.

The results from the IV approach support this finding (see Appendix Table A3.2). The coefficient for donations by others is positive and significant ($b = 0.227, p = 0.011$)[5]. Because the IV approach estimates a local average treatment effect, the coefficient indicates that for those donors whose neighbours are actually affected by invitations to donate, a one-unit increase in the number of donations per inhabitant is estimated to increase the number donations by about 22%. Next, we adjust for multiple hypothesis testing of our six hypotheses (including the mediated relationships) to control for the false discovery rate (FDR) following Benjamini and Hochberg (1995). Controlling for the FDR, the significance threshold for H1 is reduced to $p < 0.008$, which the result for H1 does not meet. Finally, after excluding potential outliers (see Appendix section A3.3 for details) the estimate for the effect of the donations of others remains similar but no longer significant ($b = 0.093, p = 0.091$). Together with the results from a robustness check using the number of donors instead of the number of donations (see Appendix Table A3.8), this this might suggest that it is (clusters of) very active donors that influence others' donation behaviour. To summarise, the result for H1 seems to be robust regarding potential time-constant and time-varying unobservables, but the estimated effect is small and therefore sensitive to the control of the FDR and exclusion of potential outliers.

**Social contagion between whom?**

As outlined above, Dutch postcodes are a good proxy for what individuals perceive as their neighbourhood, but they do not necessarily capture individuals' social networks. Based on participants' information about their 'donor network', we can explore between whom social contagion within postcodes might operate. From Figure 3.4 we can see that most donors (about 75%) know some other donors, about half of them have donors among friends, about a third have donors among family members, and about 20% of donors have a partner who also donates blood.

Our exploratory analysis shows a significant interaction effect between donations made by others in the same postcode and having a partner who is also a blood donor (Table 3.4). As shown in the right-hand panel of Figure 3.3, the effect of social contagion is much stronger for those who have a partner who is also a donor. Re-estimating Model 3 among the subsample of donors with a donating partner suggests that a one-unit increase in the number of donations per inhabitant increases the number of the individuals' donations by about 34% ($b = 0.335, p < 0.001$). For those that do not have a donating partner, the association is close to zero (see the right-hand panel of Figure 3.3). While the absence of

[5]Among donors living alone, the coefficient is negative and no longer statistically significant ($b = -0.12, p = 0.61$). The reason for the sign switch is likely that the most influential other donors (e.g., partners) are excluded.

**Table 3.3** CRE Poisson regression of blood donation attempts on others' donations and mediators, and linear CRE regression of mediators on others' donations

| | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| | Coef. | S.E. | Coef. | S.E. | Coef. | S.E. |
| **Individuals' donation attempts** | | | | | | |
| Donation attempts per inhab. | 0.108* | (0.044) | 0.102* | (0.043) | 0.105* | (0.043) |
| Male | 0.480*** | (0.026) | 0.474*** | (0.026) | 0.465*** | (0.026) |
| Income | -0.040*** | (0.008) | -0.022** | (0.008) | -0.026** | (0.008) |
| Age | -0.020*** | (0.002) | -0.021*** | (0.002) | -0.021*** | (0.002) |
| Having children | -0.115*** | (0.033) | -0.107*** | (0.032) | -0.109*** | (0.032) |
| ln(working hours + 1) | -0.021** | (0.006) | -0.019** | (0.006) | -0.020** | (0.006) |
| Previous donations | -0.007*** | (0.001) | -0.008*** | (0.001) | -0.008*** | (0.001) |
| ln(Individuals' invitations + 1) | 0.674*** | (0.014) | 0.674*** | (0.014) | 0.677*** | (0.014) |
| Permanently deferred | -0.446*** | (0.035) | -0.447*** | (0.035) | -0.452*** | (0.035) |
| Subjective norms | | | 0.021 | (0.011) | 0.016 | (0.011) |
| Self-identity | | | 0.115*** | (0.018) | 0.024 | (0.025) |
| Moral norms | | | -0.088*** | (0.013) | -0.030* | (0.015) |
| Awareness of need | | | 0.050*** | (0.012) | 0.055*** | (0.015) |
| Cognitive attitudes | | | 0.012 | (0.009) | -0.001 | (0.009) |
| Generalized social trust | | | | | 0.016 | (0.014) |
| Self-efficacy | | | | | 0.038** | (0.013) |
| Altruism | | | | | -0.016 | (0.012) |
| Affective attitudes | | | | | 0.012 | (0.010) |
| Constant | -1.087*** | (0.069) | -0.998*** | (0.069) | -0.963*** | (0.069) |
| **Subjective norms** | | | | | | |
| Donation attempts per inhab. | | | | | 0.063* | (0.032) |
| Constant | | | | | 0.001 | (0.008) |
| **Self-identity** | | | | | | |
| Donation attempts per inhab. | | | | | 0.043 | (0.029) |
| Constant | | | | | 0.001 | (0.008) |
| **Moral norms** | | | | | | |
| Donation attempts per inhab. | | | | | 0.030 | (0.029) |
| Constant | | | | | 0.003 | (0.008) |
| **Awareness of need** | | | | | | |
| Donation attempts per inhab. | | | | | -0.004 | (0.034) |
| Constant | | | | | -0.007 | (0.008) |
| **Cognitive attitudes** | | | | | | |
| Donation attempts per inhab. | | | | | 0.072* | (0.030) |
| Constant | | | | | 0.000 | (0.007) |
| *N* | 24,552 | | 24,552 | | 24,552 | |
| AIC | 106,877.1 | | 106,582.9 | | 418,945.5 | |
| BIC | 106,998.8 | | 106,753.2 | | 419,351.4 | |

Note: For the Poisson regression (where the DV is individuals' donation attempts), the coefficient multiplied by 100 approximates the percentage change in the outcome for a one-unit change in the independent variable. Statistically significant contextual effects are included (but not shown) in the regressions with individuals' donation attempts as DV, and in the regressions with the mediating constructs as DV. Estimates for all contextual effects are shown in Table A3.5. Heteroskedasticity-robust standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

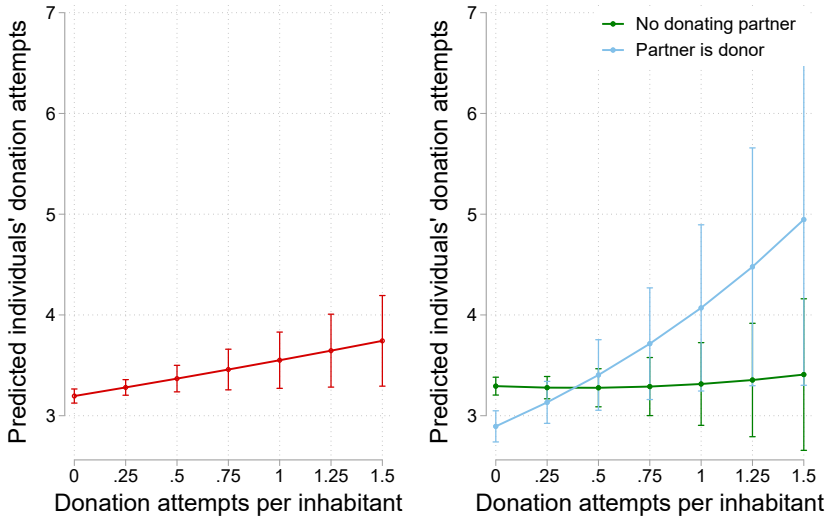


**Figure 3.3** Predicted number of individuals' blood donation attempts with 95% CIs derived from model 3 in Table 3.3. Left: Predicted number of individuals' blood donation attempts by number of donations per inhabitant. Right: Predicted number of individuals' blood donation attempts by number of donations per inhabitant and by having a partner that is a blood donor or not. Predictions are marginal with respect to the individual-specific random effect.

evidence does not necessarily mean that there is no effect, the 95% confidence interval of the estimate for those without a donating partner shows that large effects by neighbours other than the partners are generally unlikely (Lakens et al. 2020). Thus, social contagion within neighbourhoods seems to be mostly driven by social contagion within donor couples.

### 3.3.2 No evidence that normative and informational social influence mediate social contagion

Model 3 in Table 3.3 shows the results for the mediated relationships (H2-H6). The lower half of the table shows how individuals' attitudes towards blood donations change with the donation behaviour of others. Each of the potential mediators is displayed in its own row, which shows the results from a linear CRE regression of the mediator on donations by others. In line with our hypotheses, individuals' subjective norms and cognitive attitudes are positively and significantly related to the donation behaviour of others. For each one-unit increase in the number of donations per inhabitant, individuals' subjective norms are estimated to increase by about .06 units (the subjective norms measure has a range of 3.81). For each one-unit increase in the number of donations per inhabitant, individuals' cognitive attitudes are estimated to increase by about .07 units (the cognitive attitudes

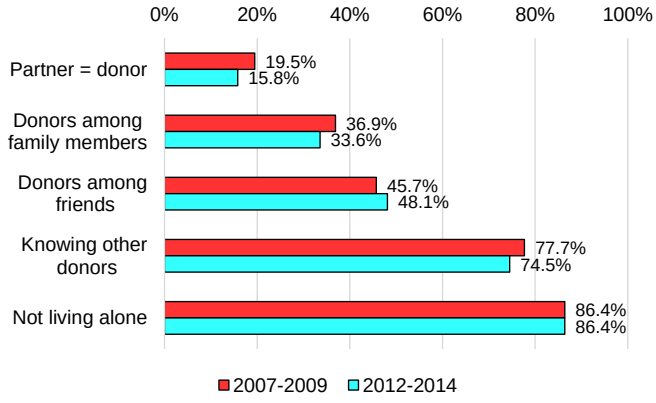


**Figure 3.4** Donors within the focal donor's social network.
Notes: Participants were asked 'Are there people among your direct acquaintances who are blood donors?' and could select several of the first three response options given above. Knowing other donors is a dummy that captures whether 'yes' was answered to any of these options. 'Not living alone' is a dummy that indicates whether donors live alone (or with children), or together with others, including potential donors.

measure has a range of 8.53). However, theses associations are small, suggesting that changes in subjective norms and cognitive attitudes are not strongly influenced by the donation behaviour of others within the neighbourhood. The remaining mediators are not significantly related to the donation behaviour of others.

The upper half of Table 3.3 shows to what extent the potential mediators affect individuals' whole blood donation attempts. Model 3 shows that a one-unit increase in individuals' moral norms about blood donations (which has a range of 4.41) is estimated to decrease the number of individuals' donations by about 3%. A one-unit increase in individuals' awareness of need for blood donations (which has a range of 5.99) is related to a 5.5% increase in the number of individuals' donations. Changes in individuals' subjective norms, self-identity, and cognitive attitudes are not associated with changes in individuals donation behaviour. Because of the strong bivariate association between self-efficacy and both self-identity and moral norms, we included the covariates stepwise in Model 3 (see Appendix Table A3.7). This shows that the coefficients of self-identity and moral norms are particularly sensitive to the inclusion of self-efficacy as a covariate, highlighting that the within-person effects of individuals' self-efficacy, self-identity, and moral norms on blood donation behaviour are highly related.

Finally, we test for evidence of mediation. From the test for the significance of the indirect effects (Figure 3.5) we see that none of them are significantly different from 0. Hypotheses 2-6 about normative and informational social influence underlying social contagion of blood donation are therefore not supported by our data.

**Table 3.4** Interaction effects of donations by others with donors in network.

| | Coef. | S.E. |
|---|---|---|
| Interaction of donations by others with: | | |
| Partner = donor | 0.335** | (0.115) |
| Donors among family members | -0.086 | (0.105) |
| Donors among friends | -0.184 | (0.110) |
| Knows any other donors | 0.070 | (0.199) |
| Not living alone | 0.313 | (0.180) |

Abbreviations: Coef. = coefficient; S.E. = standard error.
Results based on including interaction terms of donations per inhabitant with dummy variables for each of the variables for having donors within the social network and living alone.
Heteroskedasticity-robust standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

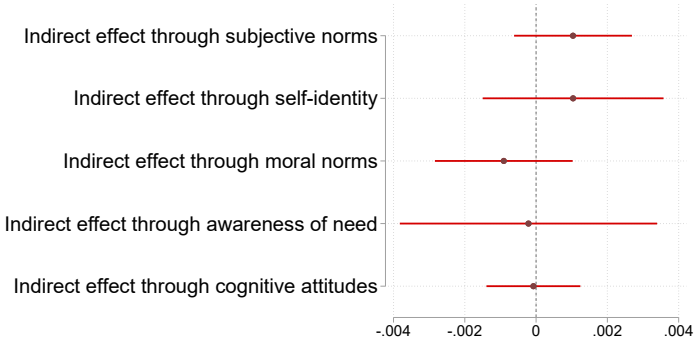


**Figure 3.5** Results of the mediation analysis.
Notes: Estimates are based on coefficients of Model 3 (see Table 3.3). Standard errors obtained via the delta method.

## 3.4 Discussion

This study has analysed how social contagion affects blood donation behaviour, a prosocial behaviour enabling life-saving transfusions and other routine medical treatments. While extensive theoretical and experimental work demonstrated that social contagion can contribute to sustaining prosocial behaviour over time, this insight had not yet been integrated into individual-centred work on repeated real-world prosocial behaviour. We linked these two strands of literature by providing a theoretical framework of social contagion through social influence. The goal of the empirical part of this study was twofold: firstly, to assess to what extent social contagion contributes to sustaining repeated blood donations; and secondly, to assess whether social contagion is mediated by normative and informational

social influence.

Our results show that social contagion does play a role for blood donation behaviour: a one-unit increase in the number of donations per inhabitant of the focal donor's neighbourhood (e.g., all others donating twice instead of once) is associated with a 11% increase in the number of whole blood donations by the focal donor. This result is robust with regard to time-constant and time-varying unobservables, but the estimated effect is small and therefore sensitive to the control of the FDR and the exclusion of potential outliers. Our exploratory analysis shows that the effect is likely driven by social contagion among donor-couples. For those donors with a donating partner, the effect is much stronger and a one-unit increase in the number of donations per inhabitant is associated with a 35% increase in the number of whole blood donations by the individual. In line with previous research, these results show that the behaviour of those that are socially close is most relevant for social contagion. This result is important for future studies: even with the use of very small-scale geographical data, a large sample, and behavioural data based on register data rather than self-reports, our study reveals only small social contagion effects, which our exploratory analysis further attributes to donor couples. Similarities in behaviour within geographical areas should therefore not simply be attributed to processes of social influence.

It is currently unclear to what extent these findings on blood donation might generalise to other forms of prosocial behaviour. In our view, they might be most readily applicable to other forms of prosocial behaviour that require planning and deliberate repeated engagement, such as donations of other bodily fluids (e.g., blood plasma, platelets) and volunteering. In contrast, generalisability to rare behaviours, such as living organ donation, is likely limited. Another limiting condition is the observability of behaviour. While blood donation and volunteering can be easily observable to others (especially to those that engage in the same behaviour), other forms of prosocial behaviour such as charitable giving are generally less observable and might therefore depend on explicit strategies of making others' behaviour visible, such as social information (van Teunenbroek et al. 2020).

We did not find evidence that social contagion is mediated by normative or informational social influence, that is blood donors' subjective norms, self-identity, moral norms, awareness of need, or cognitive attitudes about blood donation. In our data, this is for two reasons. First, most of these beliefs and attitudes do not seem to be (strongly) influenced by the donation behaviour of close neighbours, at least not in the relatively short term of about 4 years and among those that are already blood donors. The formation and change of attitudes through social learning might be more likely to occur through childhood and adolescence, for example through familial influences (Bandura 1977; Hughes et al. 2018; Quéniart 2013). In adulthood, a four-year period might not be enough for beliefs and attitudes about blood donation behaviour to change in response to others' behaviour, especially given that most donors already have favourable attitudes towards this behaviour. Second,

many of these constructs that have been found to be central for capturing between-person influences on intentions to donate blood show small and/or insignificant within-person effects on donation behaviour.

In sum, the behaviour of others seems to exert an independent influence on repeated prosocial behaviour, and it therefore remains a challenge to identify the mechanisms through which social contagion in prosocial behaviour works. One alternative explanation for social contagion could be that it is based on stable social preferences, such as inequity aversion or generalised reciprocity (Fischbacher et al. 2001; Gächter et al. 2013). These preferences do not need to change over time in order for social contagion to work.

### 3.4.1 Limitations and directions for future research

A limitation of our study is the restricted information about focal donors' social networks. While neighbourhoods cover individuals' cohabitants and direct neighbours, they do not capture relations to family members, friends, and colleagues who might be socially but not geographically close to our focal donors. An important next step for future work would be to reassess social contagion in blood donation based on longitudinal social network data.

Another promising avenue for future research would be to uncover heterogeneity in how individuals are affected by the donation behaviour of others. While our study has assumed that all individuals are positively affected by the donation behaviour of others, there might be donors who donate particularly because others do not (Ferguson and Lawrence 2016; Oliver 1984).

### 3.4.2 Implications

Two major implications follow from our results. The first concerns recruitment and retention efforts of blood banks. Many of them face declining numbers of first time and repeat blood donors, and thus need novel recruitment and retention strategies (Ferguson et al. 2020; Slonim et al. 2014). Bruhin et al. (2020) have previously shown that donation invitations are more effective when directed at donor couples rather than individuals. Similarly, our results show that blood bank retention efforts are likely to be more successful when targeted at groups, particularly donor couples. Such interventions could make the behaviour of other donors more salient, e.g., by mentioning how often others usually donate or through group-donation programmes. Our results further imply that such interventions might be more successful when focused on social networks, especially couples rather than spatially defined communities.

The second implication relates to theories of repeated prosocial behaviour. Our results show that the presumed importance of social contagion for maintaining prosocial behaviour in the literature on collective action does, to some extent, translate to a better understand-

ing of repeated real-world prosocial behaviour: social contagion can contribute to sustaining individuals' repeated prosocial behaviour. Our results are not consistent with the 'pure altruism' model of prosocial behaviour, where individuals' contributions are crowded out by the prosocial behaviour of others. We show that, on average, blood donations by individuals and others complement rather than substitute one another. Also, we do not find that the effect of social contagion is mediated by attitudinal constructs included in current theoretical models of repeated prosocial behaviour; it should therefore be included as independent predictor of individuals' repeated prosocial behaviour. Theoretical models aimed at explaining repeated prosocial behaviour would benefit from incorporating this insight.

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# Appendix A3

## A3.1 Correlation matrix

**Appendix Table A3.1** Correlation matrix of study measures.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Male | 1.00 | | | | | | | | | | | | | | | | | | |
| (2) Previous don. | 0.30 | 1.00 | | | | | | | | | | | | | | | | | |
| (3) Income | 0.55 | 0.20 | 1.00 | | | | | | | | | | | | | | | | |
| (4) Age | 0.23 | 0.43 | 0.18 | 1.00 | | | | | | | | | | | | | | | |
| (5) Sub. norms | 0.11 | 0.09 | -0.02 | 0.08 | 1.00 | | | | | | | | | | | | | | |
| (6) Self-identity | 0.00 | 0.15 | -0.11 | 0.20 | 0.58 | 1.00 | | | | | | | | | | | | | |
| (7) Mor. norms | 0.03 | 0.13 | -0.05 | 0.19 | 0.57 | 0.76 | 1.00 | | | | | | | | | | | | |
| (8) Aw. of need | 0.00 | 0.15 | -0.02 | 0.20 | 0.32 | 0.58 | 0.41 | 1.00 | | | | | | | | | | | |
| (9) Cog. attitudes | -0.04 | 0.07 | -0.04 | 0.09 | 0.22 | 0.42 | 0.23 | 0.54 | 1.00 | | | | | | | | | | |
| (10) GST | -0.02 | 0.01 | 0.13 | -0.01 | -0.21 | -0.26 | -0.18 | -0.03 | 0.01 | 1.00 | | | | | | | | | |
| (11) Altruism | -0.13 | 0.00 | -0.08 | 0.05 | 0.12 | 0.31 | 0.24 | 0.27 | 0.20 | 0.27 | 1.00 | | | | | | | | |
| (12) Self-efficacy | -0.01 | 0.14 | -0.04 | 0.15 | 0.37 | 0.70 | 0.38 | 0.55 | 0.44 | -0.02 | 0.24 | 1.00 | | | | | | | |
| (13) Aff. attitudes | 0.07 | 0.12 | -0.06 | 0.13 | 0.36 | 0.56 | 0.33 | 0.32 | 0.42 | -0.19 | 0.12 | 0.32 | 1.00 | | | | | | |
| (14) Perm. deferred | 0.02 | 0.03 | 0.02 | 0.12 | 0.01 | 0.04 | 0.04 | 0.03 | 0.02 | 0.00 | 0.02 | 0.05 | 0.05 | 1.00 | | | | | |
| (15) ln(h work+1) | 0.18 | -0.06 | 0.29 | -0.34 | -0.06 | -0.14 | -0.12 | -0.08 | -0.06 | 0.06 | -0.08 | -0.09 | -0.08 | -0.06 | 1.00 | | | | |
| (16) Children | 0.12 | 0.16 | 0.04 | 0.38 | 0.07 | 0.07 | 0.07 | 0.09 | 0.03 | -0.01 | 0.02 | 0.04 | 0.04 | 0.02 | -0.12 | 1.00 | | | |
| (17) ln(invit. +1) | 0.14 | 0.06 | 0.10 | -0.02 | 0.05 | 0.04 | 0.02 | 0.08 | 0.03 | 0.00 | -0.02 | 0.07 | 0.00 | -0.14 | 0.08 | -0.03 | 1.00 | | |
| (18) Don. per inhab. | -0.00 | 0.01 | -0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.00 | 0.02 | 0.02 | -0.00 | -0.00 | -0.02 | 0.02 | 0.02 | 1.00 | |
| (19) Indiv. don. | 0.28 | 0.07 | 0.14 | 0.13 | 0.10 | 0.12 | 0.07 | 0.11 | 0.06 | -0.03 | -0.04 | 0.15 | 0.09 | -0.10 | 0.04 | 0.05 | 0.38 | 0.03 | 1.00 |

Pearson correlation coefficients between study measures.

## A3.2 Instrumental variable approach

The results from the second stage of the instrumental variable approach are presented in Table A3.2.

**Appendix Table A3.2** Results from instrumental variable estimation.

| | Coef. | S.E. |
|---|---|---|
| **Individuals' donation attempts** | | |
| Donation attempts per inhabitant | 0.227* | (0.090) |
| Control function | -0.209 | (0.117) |
| Income | -0.030*** | (0.007) |
| Age | -0.026*** | (0.002) |
| Having children | -0.097** | (0.033) |
| ln(working hours+1) | -0.016* | (0.007) |
| Previous donations | -0.008*** | (0.000) |
| ln(individuals' invitations+1) | 0.686*** | (0.015) |
| Subjective norms | -0.011 | (0.020) |
| Moral norms | -0.155** | (0.059) |
| Awareness of need | 0.062*** | (0.016) |
| Cognitive attitudes | 0.006 | (0.011) |
| Generalized social trust | -0.078 | (0.069) |
| Self-efficacy | -0.065 | (0.054) |
| Altruistic values | -0.032 | (0.019) |
| Affective attitudes | -0.017 | (0.017) |
| *N* | 24,552 | |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## A3.3 Outliers

To check for the potential influence of outliers, we rerun our analysis (Model 3) excluding cases where the number of donations per inhabitant is more than three standard deviations from its mean. This leads to the exclusion of 528 observations.

**Appendix Table A3.3** CRE Poisson regression of individuals' blood donation attempts on peers' donation attempts and covariates with outliers 3 SD below and above the mean excluded.

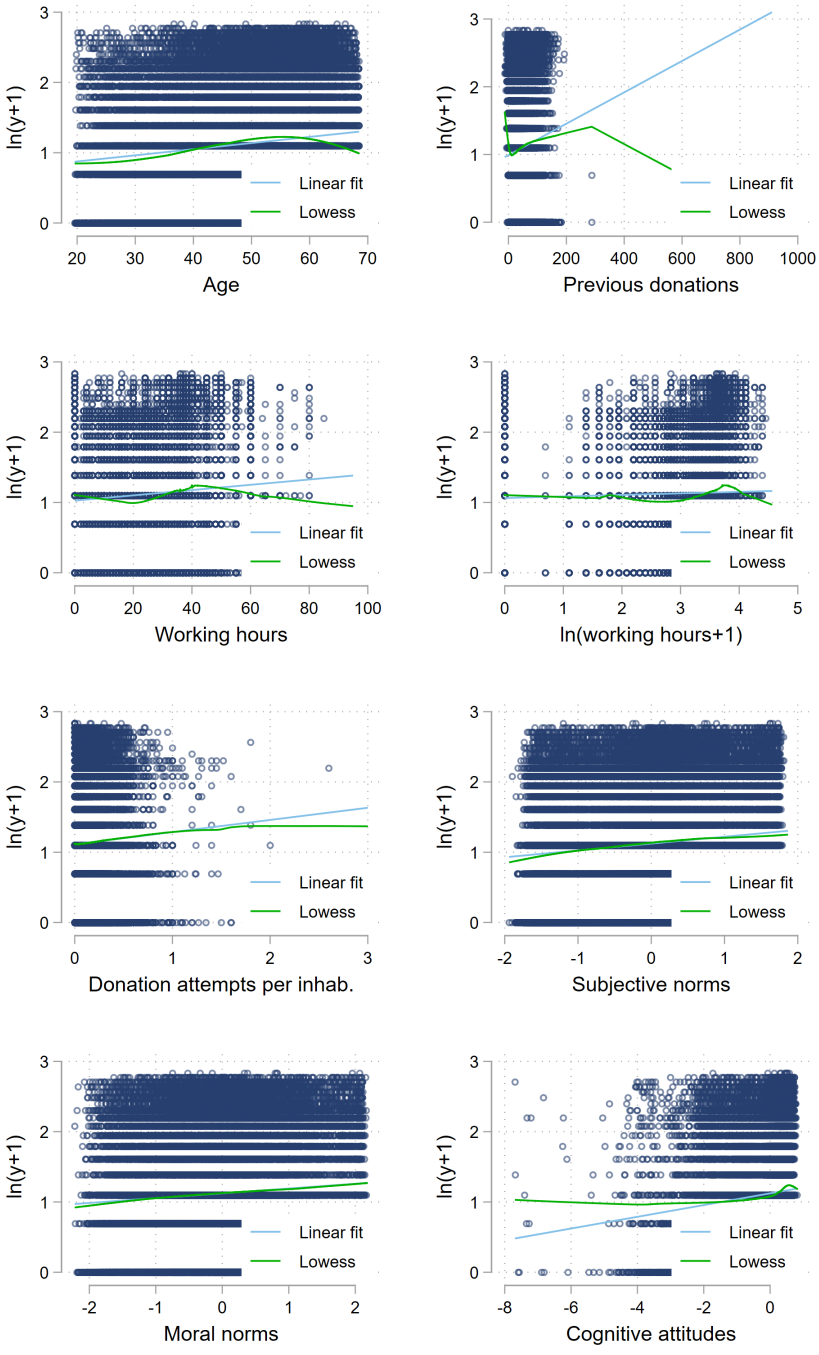
| | Coef. | S.E. |
|---|---|---|
| **Individuals' donation attempts** | | |
| Donation attempts per inhabitant | 0.093 | (0.055) |
| Male | 0.470*** | (0.026) |
| Income | -0.027** | (0.008) |
| Age | -0.021*** | (0.002) |
| Having children | -0.106** | (0.033) |
| ln(working hours+1) | -0.019** | (0.006) |
| Previous donations | -0.008*** | (0.001) |
| ln(Individuals' invitations +1) | 0.675*** | (0.014) |
| Permanently deferred | -0.456*** | (0.036) |
| Subjective norms | 0.017 | (0.011) |
| Self-identity | 0.028 | (0.026) |
| Moral norms | -0.033* | (0.015) |
| Awareness of need | 0.056*** | (0.015) |
| Cognitive attitudes | -0.003 | (0.009) |
| Generalized social trust | 0.015 | (0.014) |
| Self-efficacy | 0.037** | (0.013) |
| Altruistic values | -0.017 | (0.012) |
| Affective attitudes | 0.014 | (0.010) |
| Constant | -0.952*** | (0.069) |
| *N* | 24,137 | |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

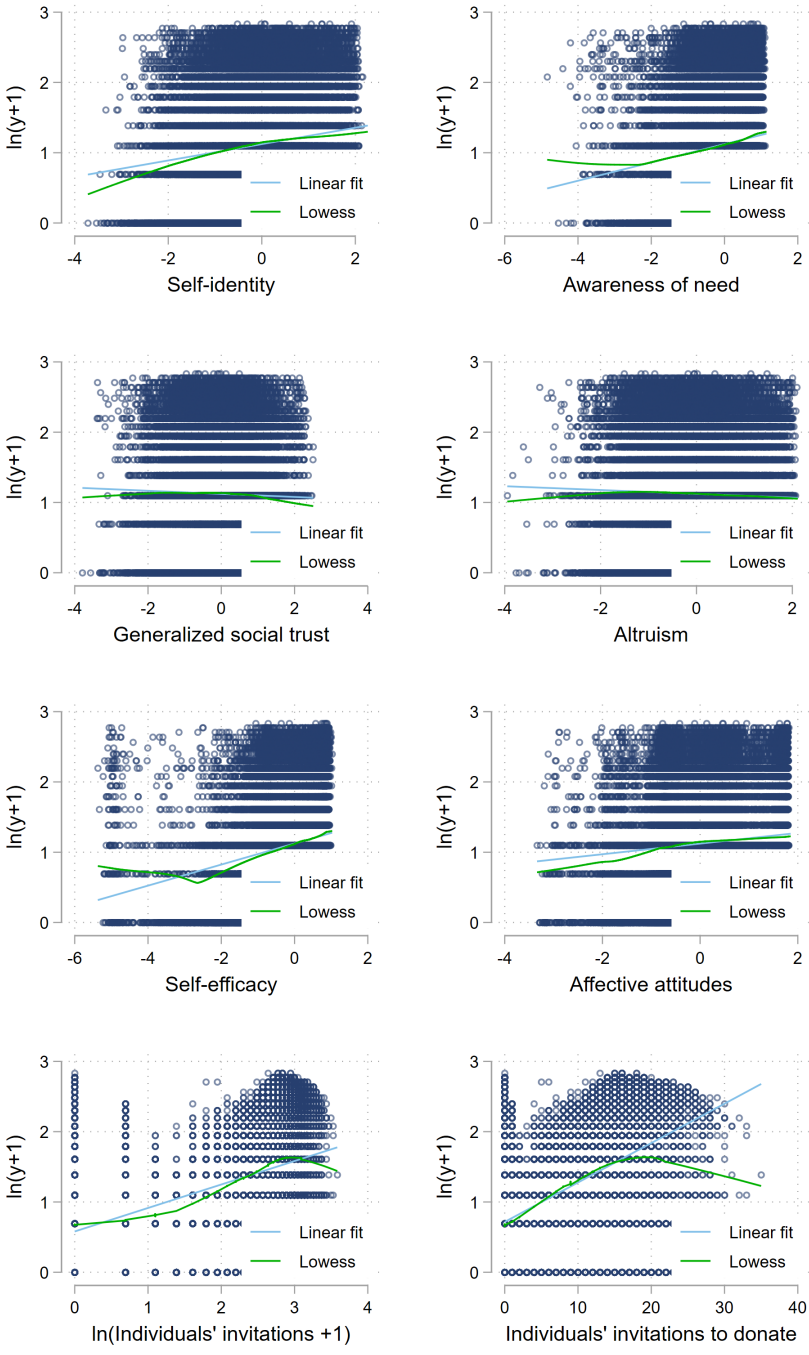
# A3.4 Assumption checks

## A3.4.1 Linearity

To assess the linearity assumption that $ln(y_i)$is a linear function of the predictors, we plot the natural logarithm of the observed counts of individuals' donation attempts + 1 against the predictors $x_{it}$, as depicted in Figure A3.1 and Figure A3.2. Individuals' invitations to donate and individuals' working hours were log-transformed to better meet the linearity assumption.



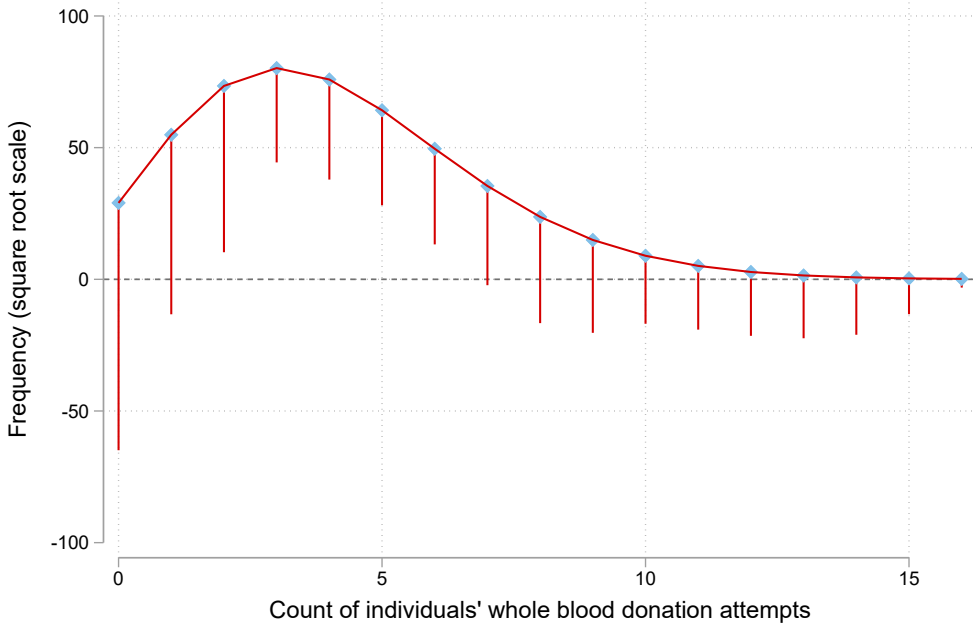

**Appendix Figure A3.1** Assessing the linearity assumption for the independent variables age, individuals' previous donations, working hours, peers' donation attempts, subjective norms about blood donations, moral norms about blood donations, and cognitive attitudes about blood donations, which are used in the structural model.




**Appendix Figure A3.2** Assessing the linearity assumption for the independent variables self-identity, awareness of need, generalized social trust (GST), altruistic values, self-efficacy, affective attitudes, and individuals' invitations to donate, which are used in the structural model.

### A3.4.2 Fit of the Poisson distribution

The Poisson model assumes equidispersion, referring to equality of the conditional variance $V$ and the conditional mean: $V[y_{it}|x_{it},\alpha_i] = \mu_{it}$. The hanging rootogram (Buis 2011) of the number of donation attempts by individuals in Figure A3.3 shows that overdispersion might be a concern in our data. The rootogram 'hangs' a histogram from the theoretical Poisson distribution. The deviations of the 'spikes' in the histogram from the zero line thus indicate deviations from the theoretical distribution. The wave-like deviations from the Poisson distribution we observe in Figure A3.3 indicate unconditional overdispersion: there are more small counts (zeros) and large counts than a Poisson distribution with mean 3.58 (the sample mean of individuals' donation attempts) would predict, while there are fewer observed counts around the mean. Considerable overdispersion is also suggested by a comparison of the sample variance with the sample mean, with the sample variance (15.88) being 4.44 times the sample mean (3.58).




**Appendix Figure A3.3** Hanging rootogram comparing the observed counts to a theoretical Poisson distribution.

To test for potential remaining overdispersion after the inclusion of the regressors and the individual-specific effect $\alpha_i$, we compare the Poisson model to the 'NB2 model' (Cameron and Trivedi 2013). The latter specifies the variance as $V[y_{it}|x_{it},\alpha_i] = \mu_{it}+(\mu_{it})^2\alpha$, and thus allows for additional dispersion in comparison to the Poisson model. With a dis-

persion parameter $\alpha$ of zero, the NB2 model reduces to the Poisson model. Table A3.4 shows that there is no remaining overdispersion after the inclusion of regressors and the individual-specific random effect: after ten iterations, the dispersion parameter $\alpha$ is estimated to be essentially zero, and estimation fails to converge because alpha is defined to be non-zero. Hence, we apply the Poisson model in our analyses.

**Appendix Table A3.4** Comparison of Poisson with NB2 Model

| | Poisson (1) | | NB2 (1) | | Poisson (2) | | NB2 (2) | |
|---|---|---|---|---|---|---|---|---|
| **Individuals' donation attempts** | | | | | | | | |
| Donation attempts per inhabitant | 0.102* | (0.043) | 0.102* | (0.043) | 0.105* | (0.043) | 0.106* | (0.043) |
| Male | 0.474*** | (0.026) | 0.474*** | (0.026) | 0.465*** | (0.026) | 0.465*** | (0.026) |
| Income | -0.022** | (0.008) | -0.022** | (0.008) | -0.026** | (0.008) | -0.026** | (0.008) |
| Age | -0.021*** | (0.002) | -0.021*** | (0.002) | -0.021*** | (0.002) | -0.021*** | (0.002) |
| Having children | -0.107*** | (0.032) | -0.107*** | (0.032) | -0.109*** | (0.032) | -0.109*** | (0.032) |
| ln(work h+1) | -0.019** | (0.006) | -0.019** | (0.006) | -0.020** | (0.006) | -0.020** | (0.006) |
| Previous donations | -0.008*** | (0.001) | -0.008*** | (0.001) | -0.008*** | (0.001) | -0.008*** | (0.001) |
| ln(Indiv. invit. +1) | 0.674*** | (0.014) | 0.674*** | (0.014) | 0.677*** | (0.014) | 0.677*** | (0.014) |
| Permanently deferred | -0.447*** | (0.035) | -0.447*** | (0.035) | -0.452*** | (0.035) | -0.452*** | (0.035) |
| Subjective norms | 0.021 | (0.011) | 0.021 | (0.011) | 0.016 | (0.011) | 0.016 | (0.011) |
| Self-identity | 0.115*** | (0.018) | 0.115*** | (0.018) | 0.024 | (0.025) | 0.024 | (0.025) |
| Moral norms | -0.088*** | (0.013) | -0.088*** | (0.013) | -0.030* | (0.015) | -0.030* | (0.015) |
| Cognitive attitudes | 0.012 | (0.009) | 0.012 | (0.009) | -0.001 | (0.009) | -0.001 | (0.009) |
| GST | | | | | 0.016 | (0.014) | 0.016 | (0.014) |
| Self-efficacy | | | | | 0.038** | (0.013) | 0.038** | (0.013) |
| Constant | -0.998*** | (0.069) | -0.998*** | (0.069) | -0.963*** | (0.069) | -0.963*** | (0.069) |
| ln(alpha) | | | -15.002 | | | | -14.198 | |
| *N* | 24,552 | | 24,552 | | 24,552 | | 24,552 | |

Notes: Models NB2 (1) and NB2 (2) fail to converge because the dispersion parameter alpha cannot be estimated as it is defined to be positive. Displayed results for these models are therefore based on 10 iterations. Heteroskedasticity-robust standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

## A3.5 Additional results

**Appendix Table A3.5** Results of the CRE Poisson SEM with test for all contextual effects

| | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| **Individuals' donation attempts** | | | | | | |
| Donation attempts per inhabitant | 0.096 | (0.052) | 0.098 | (0.052) | 0.098 | (0.052) |
| Male | 0.479*** | (0.026) | 0.471*** | (0.026) | 0.464*** | (0.026) |
| Income | -0.041*** | (0.008) | -0.022** | (0.008) | -0.027** | (0.008) |
| Age | -0.019*** | (0.002) | -0.021*** | (0.002) | -0.021*** | (0.002) |
| Having children | -0.116*** | (0.033) | -0.109*** | (0.032) | -0.110*** | (0.032) |
| ln(working hours+1) | -0.021*** | (0.006) | -0.019** | (0.006) | -0.019** | (0.006) |
| Previous donations | -0.007*** | (0.001) | -0.008*** | (0.001) | -0.008*** | (0.001) |
| ln(Individuals' invitations +1) | 0.672*** | (0.014) | 0.673*** | (0.014) | 0.675*** | (0.014) |
| Permanently deferred | -0.474*** | (0.046) | -0.469*** | (0.046) | -0.466*** | (0.046) |
| mean_othersdon | 0.038 | (0.094) | 0.018 | (0.094) | 0.027 | (0.093) |
| mean_age | 0.042*** | (0.002) | 0.042*** | (0.002) | 0.042*** | (0.002) |
| mean_children | 0.095* | (0.043) | 0.084* | (0.043) | 0.100* | (0.043) |
| mean_ln_workh | 0.071*** | (0.012) | 0.068*** | (0.012) | 0.070*** | (0.012) |
| mean_ln_i_invit | -0.242*** | (0.017) | -0.251*** | (0.017) | -0.261*** | (0.017) |
| mean_defer | 0.086 | (0.064) | 0.072 | (0.064) | 0.038 | (0.064) |
| Subjective norms | | | 0.007 | (0.014) | 0.002 | (0.015) |
| Self-identity | | | 0.115*** | (0.021) | 0.120* | (0.056) |
| Moral norms | | | -0.073*** | (0.018) | -0.075** | (0.026) |
| Awareness of need | | | 0.053*** | (0.015) | 0.057*** | (0.016) |
| Cognitive attitudes | | | 0.005 | (0.010) | 0.004 | (0.011) |
| mean_Subnorm | | | 0.031 | (0.021) | 0.016 | (0.022) |
| mean_Selfid | | | 0.071* | (0.029) | -0.119 | (0.063) |
| mean_Mornorm | | | -0.029 | (0.026) | 0.062 | (0.033) |
| mean_Awneed | | | -0.017 | (0.024) | -0.059* | (0.025) |
| mean_Cogatt | | | 0.036 | (0.022) | -0.019 | (0.023) |
| Generalized social trust | | | | | -0.109 | (0.072) |
| Self-efficacy | | | | | 0.006 | (0.023) |
| Altruism | | | | | -0.009 | (0.015) |
| Affective attitudes | | | | | 0.009 | (0.012) |
| mean_Gst | | | | | 0.128 | (0.073) |
| mean_Selfeff | | | | | 0.259*** | (0.030) |
| mean_Altruism | | | | | -0.073*** | (0.021) |
| mean_Affatt | | | | | 0.058** | (0.020) |
| Constant | -1.091*** | (0.069) | -1.011*** | (0.069) | -0.962*** | (0.069) |
| **Subjective norms** | | | | | | |
| Donation attempts per inhabitant | | | | | 0.078 | (0.043) |
| mean_othersdon | | | | | -0.037 | (0.068) |
| Constant | | | | | 0.003 | (0.009) |
| **Self-identity** | | | | | | |
| Donation attempts per inhabitant | | | | | 0.007 | (0.034) |
| mean_othersdon | | | | | 0.122 | (0.067) |
| Constant | | | | | -0.007 | (0.009) |
| **Moral norms** | | | | | | |
| Donation attempts per inhabitant | | | | | -0.004 | (0.036) |
| mean_othersdon | | | | | 0.110 | (0.067) |
| Constant | | | | | -0.005 | (0.009) |
| **Awareness of need** | | | | | | |
| Donation attempts per inhabitant | | | | | -0.004 | (0.034) |
| mean_othersdon | | | | | 0.172** | (0.056) |
| Constant | | | | | -0.007 | (0.008) |
| **Cognitive attitudes** | | | | | | |
| Donation attempts per inhabitant | | | | | 0.040 | (0.045) |
| mean_othersdon | | | | | 0.059 | (0.062) |
| Constant | | | | | -0.002 | (0.007) |
| *N* | 24,552 | | 24,552 | | 24,552 | |

Heteroskedasticity-robust standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

**Appendix Table A3.6** CRE SEM for subsample of donors who ever had a donating partner

| | (1) | |
|---|---|---|
| **Individuals' donation attempts** | | |
| Donation attempts per inhabitant | 0.335*** | (0.078) |
| Male | 0.437*** | (0.053) |
| Income | -0.037* | (0.016) |
| Age | -0.022*** | (0.004) |
| Having children | -0.092* | (0.045) |
| ln(working hours+1) | 0.020 | (0.013) |
| Previous donations | -0.008*** | (0.001) |
| ln(Individuals' invitations +1) | 0.671*** | (0.029) |
| Permanently deferred | -0.344*** | (0.066) |
| Subjective norms | 0.026 | (0.023) |
| Self-identity | 0.009 | (0.051) |
| Moral norms | -0.004 | (0.031) |
| Awareness of need | 0.051 | (0.027) |
| Cognitive attitudes | -0.034 | (0.021) |
| Generalized social trust | 0.017 | (0.028) |
| Self-efficacy | 0.067* | (0.027) |
| Altruism | -0.093*** | (0.021) |
| Affective attitudes | 0.033 | (0.019) |
| Constant | -0.800*** | (0.130) |
| **Subjective norms** | | |
| Donation attempts per inhab. | 0.107 | (0.059) |
| Constant | 0.005 | (0.016) |
| **Self-identity** | | |
| Donation attempts per inhab. | -0.011 | (0.056) |
| Constant | -0.057** | (0.019) |
| **Moral norms** | | |
| Donation attempts per inhab. | -0.054 | (0.061) |
| Constant | -0.014 | (0.018) |
| **Awareness of need** | | |
| Donation attempts per inhab. | -0.042 | (0.060) |
| Constant | -0.021 | (0.016) |
| **Cognitive attitudes** | | |
| Donation attempts per inhab. | 0.146** | (0.046) |
| Constant | -0.003 | (0.013) |
| *N* | 7,006 | |

Heteroskedasticity-robust standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

**Appendix Table A3.7** Results stepwise mediation model

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| **Individuals' donation attempts** | | | | | | | | |
| Donation attempts per inhabitant | 0.102* | (0.043) | 0.102* | (0.043) | 0.105* | (0.043) | 0.104* | (0.043) |
| Male | 0.478*** | (0.026) | 0.494*** | (0.026) | 0.456*** | (0.026) | 0.473*** | (0.026) |
| Income | -0.023** | (0.008) | -0.029*** | (0.008) | -0.021* | (0.008) | -0.025** | (0.008) |
| Age | -0.021*** | (0.002) | -0.021*** | (0.002) | -0.021*** | (0.002) | -0.022*** | (0.002) |
| Having children | -0.108*** | (0.032) | -0.108*** | (0.032) | -0.109*** | (0.032) | -0.104** | (0.032) |
| ln(working hours+1) | -0.019** | (0.006) | -0.019** | (0.006) | -0.019** | (0.006) | -0.018** | (0.006) |
| Previous donations | -0.008*** | (0.001) | -0.008*** | (0.001) | -0.008*** | (0.001) | -0.008*** | (0.001) |
| ln(Individuals' invitations +1) | 0.673*** | (0.014) | 0.676*** | (0.014) | 0.674*** | (0.014) | 0.672*** | (0.014) |
| Permanently deferred | -0.447*** | (0.035) | -0.453*** | (0.035) | -0.444*** | (0.035) | -0.446*** | (0.035) |
| Subjective norms | 0.018 | (0.011) | 0.020 | (0.011) | 0.017 | (0.011) | 0.016 | (0.011) |
| Self-identity | 0.124*** | (0.019) | 0.043* | (0.022) | 0.125*** | (0.019) | 0.146*** | (0.016) |
| Moral norms | -0.090*** | (0.013) | -0.043** | (0.015) | -0.085*** | (0.013) | -0.085*** | (0.013) |
| Awareness of need | 0.052*** | (0.012) | 0.054*** | (0.015) | 0.051*** | (0.012) | 0.052*** | (0.012) |
| Cognitive attitudes | 0.014 | (0.009) | 0.005 | (0.009) | 0.005 | (0.010) | 0.006 | (0.009) |
| Generalized social trust | -0.105 | (0.056) | | | | | | |
| Self-efficacy | | | 0.030* | (0.012) | | | | |
| Altruism | | | | | -0.022 | (0.012) | | |
| Affective attitudes | | | | | | | 0.019* | (0.009) |
| Constant | -0.990*** | (0.069) | -0.972*** | (0.069) | -0.992*** | (0.069) | -1.016*** | (0.069) |
| *N* | 24,552 | | 24,552 | | 24,552 | | 24,552 | |

Heteroskedasticity-robust standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

**Appendix Table A3.8** CRE Poisson regression of individuals' blood donation attempts on the number of other donors and covariates

| | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| **Individuals' whole blood donation attempts** | | | | | | |
| Number of donors per inhab. | -0.008 | (0.055) | -0.005 | (0.054) | -0.010 | (0.054) |
| Male | 0.480*** | (0.026) | 0.474*** | (0.026) | 0.499*** | (0.021) |
| Income | -0.041*** | (0.008) | -0.022** | (0.008) | -0.026*** | (0.007) |
| Age | -0.020*** | (0.002) | -0.021*** | (0.002) | -0.019*** | (0.002) |
| Having children | -0.116*** | (0.033) | -0.107*** | (0.032) | -0.025 | (0.019) |
| ln(working hours+1) | -0.021** | (0.006) | -0.019** | (0.006) | -0.016* | (0.007) |
| Previous donations | -0.007*** | (0.001) | -0.008*** | (0.001) | -0.005*** | (0.000) |
| ln(Individuals' invitations +1) | 0.675*** | (0.014) | 0.674*** | (0.014) | 0.439*** | (0.012) |
| Permanently deferred | -0.446*** | (0.035) | -0.446*** | (0.035) | -0.398*** | (0.035) |
| Subjective norms | | | 0.021 | (0.011) | 0.005 | (0.015) |
| Self-identity | | | 0.115*** | (0.018) | 0.080 | (0.058) |
| Moral norms | | | -0.088*** | (0.013) | -0.058* | (0.027) |
| Awareness of need | | | 0.050*** | (0.012) | 0.037* | (0.017) |
| Cognitive attitudes | | | 0.013 | (0.009) | -0.003 | (0.011) |
| Generalized social trust | | | | | 0.008 | (0.011) |
| Self-efficacy | | | | | 0.017 | (0.023) |
| Altruism | | | | | -0.017 | (0.013) |
| Affective attitudes | | | | | 0.007 | (0.012) |
| Constant | -1.076*** | (0.069) | -0.989*** | (0.069) | -0.325*** | (0.059) |
| **Subjective norms** | | | | | | |
| Number of donors per inhab. | | | | | -0.079 | (0.041) |
| Constant | | | | | 0.024* | (0.011) |
| **Self-identity** | | | | | | |
| Number of donors per inhab. | | | | | 0.049 | (0.039) |
| Constant | | | | | -0.005 | (0.011) |
| **Moral norms** | | | | | | |
| Number of donors per inhab. | | | | | 0.118** | (0.040) |
| Constant | | | | | -0.019 | (0.011) |
| **Awareness of need** | | | | | | |
| Number of donors per inhab. | | | | | 0.040 | (0.038) |
| Constant | | | | | 0.001 | (0.010) |
| **Cognitive attitudes** | | | | | | |
| Number of donors per inhab. | | | | | 0.093* | (0.038) |
| Constant | | | | | -0.012 | (0.010) |
| Observations | 24,551 | | 24,551 | | 29,260 | |

Note: Other donors are defined as those that made a donation and/or received an invitation to donate in a given year.
Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

# Chapter 4

# Did you donate? Talking about donations predicts compliance with solicitations for donations

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## Abstract

Many forms of prosocial behaviour are highly institutionalised. They are facilitated by organisations that broker between donors and recipients. A highly effective tool that organisations use to elicit prosocial behaviour are solicitations for donations (e.g., of blood, time, or money). Using register and survey data on blood donations in the Netherlands, we examine to what extent compliance with these solicitations is predicted by being recruited via word of mouth (WOM) and talking about donations. Our model predicts that donors that are one unit higher on our measure of talking about donations (range = 1-4) have a 2.9 percentage points higher compliance with solicitations for donations. In addition, this association is stronger for novice donors. Our study demonstrates the social embedding of the donors' decision-making processes about compliance. For practice, our results imply that organisations may increase their contributors' communication about donations to increase the effectiveness of their solicitations.

## 4.1 Introduction

Many forms of prosocial behaviour are highly institutionalised. They are structured and facilitated by organisations that serve as brokers between donors and recipients (Gorleer et al. 2020; Healy 2004). One of the key tools that organisations use to elicit prosocial behaviour are solicitations for donations (Bekkers 2005; Merz, Zijlstra, and de Kort 2017; Yörük 2008). These solicitations are a powerful factor determining an individual's prosocial behaviour in the forms of blood donations (Merz, Zijlstra, and de Kort 2017; Wevers et al. 2014), charitable giving (Andreoni 2006; Bekkers and Wiepking 2011; Yörük 2009), and volunteering (Freeman 1997; Yörük 2008). Nevertheless, not every solicitation results in a donation, which raises the question of what determines their effectiveness.

Research has shown that an individual's probability of compliance with a solicitation depends on the content and the procedure of solicitations themselves (Andreoni et al. 2017; Cialdini and Ascani 1976; Fajardo et al. 2018; Guéguen 2013). However, even when solicitations are uniform in procedure, format, and content, there are large variations in the compliance with solicitations between individuals and social contexts. There is some evidence that these variations are explained by the characteristics of individuals (e.g., their socio-demographic characteristics, perceptions, and attitudes) (Freeman 1997; Wevers et al. 2014), and by characteristics of the social and physical context (e.g., presence of opportunities to give or social norms related to prosocial behaviour) (Merz, Zijlstra, and de Kort 2017). Previous research further shows that social contexts that allow for social influences to be at work promote prosocial behaviour (Simpson and Willer 2015). For example, simply allowing for communication between (potential) contributors is a highly effective strategy for increasing contributions in public goods games (Balliet 2010). In addition, individual exposure to social influences has been shown to affect blood donation behaviour (Bruhin et al. 2020; Goette and Tripodi 2021). These studies highlight that the decision about prosocial behaviour is dependent on the link between individuals and their social environment. But even though most donations are made in response to a solicitation, we know little about how this social embeddedness shapes compliance behaviour.

In this study, we analyse the social embeddedness of compliance behaviour by looking at two factors linking donors to their social environment: talking about donations and being recruited via word of mouth (WOM). To conceptualise donor behaviour and to acknowledge that factors at different levels (e.g., the social and physical context, and individual characteristics) impact the individuals' decision to donate, we develop a theoretical model that integrates existing theories of donor decision-making into social-ecological systems (SES) analysis (Bronfenbrenner 1979; McGinnis and Ostrom 2014; Schlüter et al. 2017). Empirically, we study compliance with solicitations to donate whole blood in the Netherlands. We make use of register data on about 157000 solicitations for donations and a large-scale

survey among a sample of 24045 registered blood donors in the Netherlands, which was linked on the individual level.

The main contribution of this paper is twofold: First, we recognise solicitations for donations as a distinct level of analysis and demonstrate the social embedding of the decision-making process about compliance with these solicitations. Higher talking about blood donations is associated with higher compliance with solicitations for donations, and especially so among novice donors. This is in line with previous findings on social influences on general prosocial behaviour, and especially studies that have highlighted the importance of communication for increasing contributions to public goods. The interaction effect with experience further shows the importance of habit formation in the decision-making process, as external (social) influences seem to become less relevant as compliance becomes increasingly habitual. In addition, our study illustrates the differential role of altruistic values for compliance rather than general prosocial behaviour. For compliance behaviour, social influences in the form of talking about donations do not seem to be more important for the compliance of individuals with low altruistic values. This is in contrast to empirical findings on general prosocial behaviour, where social influences are typically more important for those with lower altruistic values (Feinberg et al. 2012; Simpson and Willer 2008). In addition, exploratory analysis shows that altruistic values are overall negatively associated with compliance.

Second, our study informs the practice of organisations dependent on the effectiveness of solicitations for donations. Blood has a limited shelf life and demand is changing continuously. Knowing about the factors that determine the compliance with solicitations for donations is therefore essential to determine the number of necessary solicitations to ensure a sufficient blood stock. Our results imply that organisations could invest in communication about donations and/or recruitment among potentially more communicative donors to increase the compliance with solicitations for donations and increase their effectiveness. One such interventions could be group-donation programmes, where donors can join a group of donors that they can talk to and donate with.

## 4.2 A social-ecological systems model of compliance with solicitations for donations

To conceptualise compliance behaviour, we draw on a SES framework (Bronfenbrenner 1979; McGinnis and Ostrom 2014; Ostrom 2010; Schlüter et al. 2017). A core characteristic of SES analysis is the observation that individuals' decision-making is influenced by the social and physical context that they are embedded in (McGinnis and Ostrom 2014; Schlüter et al. 2017). In the case of blood donations, the collection sites are one social context relevant to the decision-making process about compliance behaviour. Blood donations

require physical presence at a collection site, and these sites are therefore spaces where different donors experience the same facilities, the same staff, and where donors might meet and communicate with each other. In the Netherlands, all blood donations are collected by the non-profit organisation Sanquin and are voluntary and non-remunerated. Prospective donors register to become a donor with the blood bank, for example after being recruited by a friend. After registration, donors undergo an initial health screening and, if they are eligible, are added to the donor database. Subsequently, donors are repeatedly solicited to make a donation at a specific collection site (typically close to where they live or work), based on the current demand for their blood type. Figure 4.1 illustrates this structure: solicitations to donate are sent out to donors, who make donations at a specific collection site.

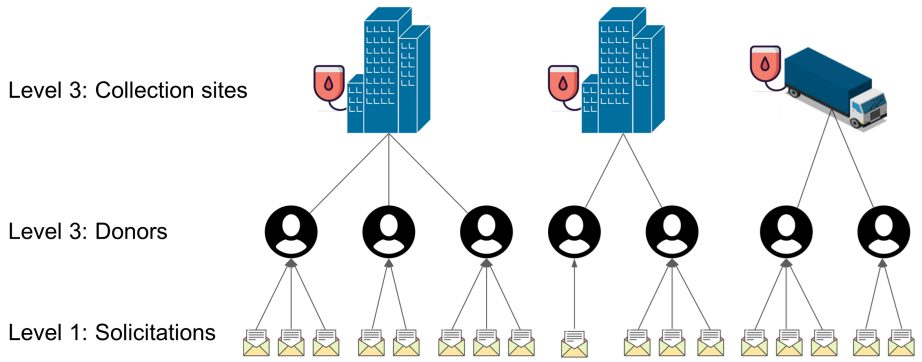


**Figure 4.1** Levels of analysis: solicitations, individuals, and collection sites.
Notes: Buildings represent fixed collection sites. The truck represents a mobile collection site.

At the same time, the SES perspective views individuals as autonomous agents. Their decisions are based on individual characteristics such as perceptions, socio-demographics, and attitudes. We build on the SES framework by Schlüter et al. (2017), where decision-making is captured by the four processes of perception, evaluation, selection of behaviour, and behaviour. These components are central to multiple theories of human decision-making, and they form the basis for our theoretical model of compliance behaviour within the social and physical context of the collection sites, which is depicted in Figure 4.2. The dashed outer box represents the collection sites as the social and physical context, with its characteristics in the blue inner box. The individual is represented by the dashed inner box, with their characteristics given in the red inner box. In this model, decision-making (represented by ellipses) starts with an individual's perception of their social and physical environment. The individual then evaluates new information and potentially updates their own characteristics based on these inputs. The individual's characteristics feed into the process of selecting a behaviour. Finally, a behaviour is executed and potentially affects

the characteristics of the social and physical environment. Below, we develop a model of compliance behaviour and state hypotheses about its social embeddedness, which we will test in the empirical analysis.

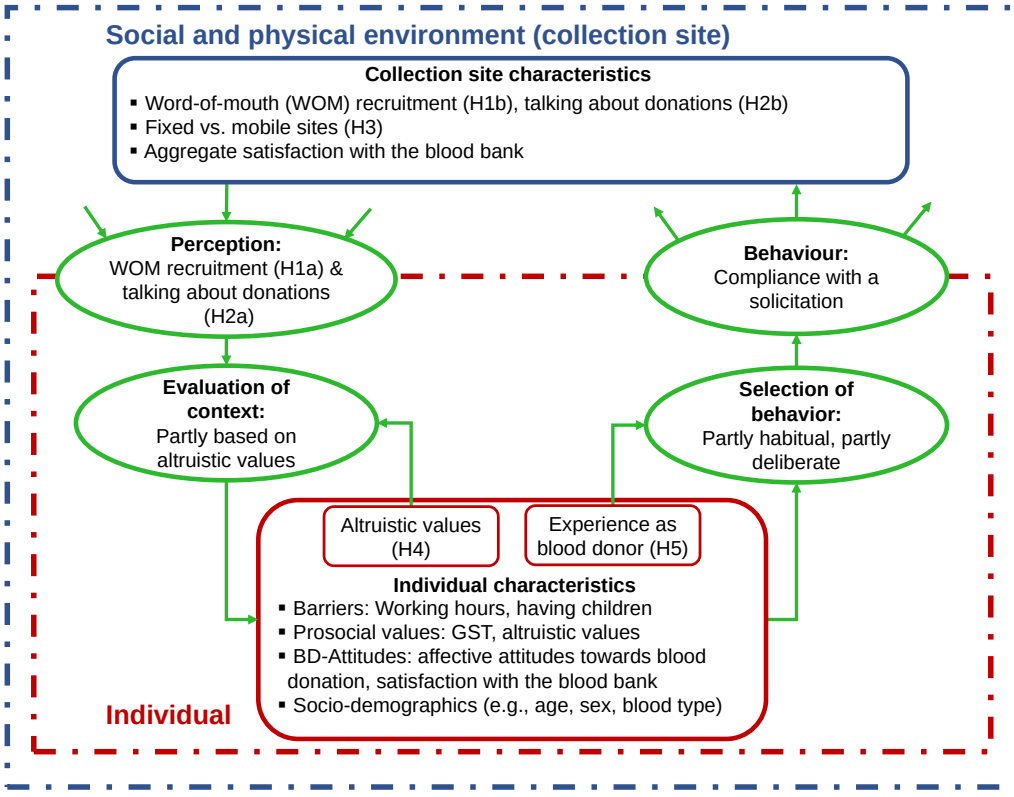


**Figure 4.2** Conceptual model of compliance with solicitations for donations.
Notes: Structural elements are depicted as boxes, and elements of the decision-making process are depicted as ellipses.

### 4.2.1 Perception

Perception is the process by which an individual senses the surrounding social and physical environment (Schlüter et al. 2017). Important components of perception of the social environment are social interactions and communication. For example, norms and expectations for behaviour emerge via communication and interaction among individuals (Ostrom 2000; Simpson and Willer 2015). We consider two factors of perception that link individuals to their social environment, namely being recruited via WOM, and talking about donations.

**Recruitment and communication — individual level**

Becoming a blood donor typically starts with being recruited by either the blood bank or via WOM, that is, informal person-to-person communication (Valente 2012; Williams and Buttle 2013). If one is recruited via WOM, the recruiters are typically partners, family or friends. In comparison to donors recruited via other channels, donors that were recruited via WOM might additionally be motivated by social influences from their recruiters and therefore be more likely to comply with a solicitation. In line with this argument, Piersma and Klinkenberg (2018) have shown that blood donors recruited by other donors have a higher donation frequency than those that signed up on their own initiative or because of promotions by the blood bank. In comparison to their study, however, WOM recruitment captures a broader range of recruitment through others, because these others are not necessarily donors themselves. Nevertheless, we expect a positive association and hypothesise:

*Hypothesis 1a: The probability of compliance with a solicitation for a donation is higher for donors that were recruited via word of mouth.*

Communication among individuals is one of the most successful strategies for promoting cooperation and prosocial behaviour (Balliet 2010; Ostrom 2010). Explanations for the effectiveness of communication include that it conveys information about need, expectations about others' behaviour, norms and their enforcement, and that it fosters group identities and emotions which promote donations (Balliet 2010; Deutsch and Gerard 1955; Simpson and Willer 2015; Sparks et al. 2019). In the case of blood donations, talking about donations might convey such motivations. The more a donor talks about donations, the more they should be affected by such motivations. As such, we hypothesise:

*Hypothesis 2a: The probability of compliance with a solicitation for a donation is higher for donors that talk more about blood donations.*

**Recruitment and communication — collection site level**

In addition to variation on the individual level, the level of WOM recruitment and talking about donations might vary between collection sites. These differences might affect compliance rates irrespective of whether a donor was recruited via WOM or talks about donations. For example, talking about blood donations can increase the salience of a social norm for blood donation. In addition, social interactions related to blood donations provide an opportunity for indirect reciprocity to occur, where a person who helps another later receives help from a third person (not necessarily in the same domain) (Simpson et al. 2018; Tsvetkova and Macy 2014). A higher proportion of people recruited via WOM, as

well as more talking about blood donations on the collection-site level might indicate that blood donorship is more closely tied to these social mechanisms, even if an individual donor might not be embedded in a network of blood donors themself. The proportion of donors recruited via WOM, and the average talking about donations at the collection site level should thus be positively related to the individual's compliance with a solicitation.

*Hypothesis 1b: The probability of compliance with a solicitation for a donation increases with the proportion of donors recruited via word of mouth at the collection site level.*

*Hypothesis 2b: The probability of compliance with a solicitation for a donation increases with the average talking about donations at the collection-site level.*

**The role of fixed versus mobile collection sites**

Social proximity has been shown to moderate the effect of social influences (Bond et al. 2012), including for the case of blood donations (Goette and Tripodi 2021). While we have no specific information on who interacts with whom, we can use information about collection sites as a proxy for social closeness among (potentially) interacting donors. In the Netherlands, blood is collected at fixed and mobile sites. Fixed collection sites are placed in larger cities and have extended opening hours. Donors registered at fixed sites are invited to donate during a two-week walk-in period starting shortly after receiving the solicitation letter. Mobile collection sites are used to collect blood in less densely populated areas such as smaller towns and villages, and therefore draw on a smaller pool of donors than fixed collection sites. Because social networks are spatially clustered (Onnela et al. 2011), these donors are more likely to know other donors donating at the same collection site. In addition, donors at mobile collection sites are invited to donate at a specific date rather than within a two-week walk-in period. Together, these factors imply that donors invited to a mobile site are more likely to meet and talk to other donors that they know. The relation between talking about donations and compliance might therefore be stronger at mobile rather than fixed donation sites.

*Hypothesis 3: The relationship between the compliance and talking about donations is moderated by the type of collection site (fixed or mobile) such that it is stronger at mobile collection sites.*

### 4.2.2 Evaluation

Evaluation is the 'process by which an individual determines the significance, worth, or condition of the perceived state of the social and bio-physical environment' (Schlüter et al. 2017, p. 25).

#### The role of altruistic values

Simpson and Willer (2015) argue that social influences are stronger on more egoistically as compared to altruistically motivated individuals. This is because more egoistically motivated individuals are typically unlikely to contribute to public goods but might be motivated by social influence. Altruistically motivated individuals, on the other hand, are more likely to contribute in the first place. In an empirical study, (Simpson and Willer 2008) found that egoistically motivated individuals indeed did respond more strongly to reputational incentives than altruistically motivated individuals. Similarly, Feinberg et al. (2012) have shown that the threat of gossip via communication more strongly promotes cooperation of egoistically motivated than altruistically motivated individuals. If talking about donations (partly) captures gossip and reputational mechanisms, it should be primarily related to the compliance of donors with lower altruistic values.

*Hypothesis 4: The relationship between the compliance with a solicitation for a donation and talking about donations is moderated by the altruistic values of individuals, such that it is stronger for those with lower altruistic values.*

### 4.2.3 Selection of behaviour

Selection of behaviour is the process by which individuals choose a behaviour based on their individual characteristics (Schlüter et al. 2017).

#### The role of experience as a blood donor

The literature on blood donation behaviour has revealed that the selection of a behavioural option becomes partly habitual over the course of a blood donor career (Bruhin et al. 2021; Wevers et al. 2014). A behaviour becomes more habitual the more it is performed, which is why the number of previous donations is often used as an indicator for habit formation. Once a strong habit is developed, the decision whether or not to donate is made with little conscious deliberation (Charng et al. 1988). External factors, such as social influence, should therefore become less relevant with more experience as a blood donor (Charng et al. 1988; Ferguson 2015; Masser et al. 2008). We hypothesise that:

*Hypothesis 5: The relationship between the compliance with a solicitation for a donation and talking about donations is moderated by experience, such that it is weaker for more experienced donors.*

## 4.3 Data

Our empirical analysis makes use of register and survey data. Data from the blood bank information system (Sanquin 2020) provides information on solicitations and donations of individuals. Importantly, the use of register data mitigates problems of potential observability bias or recall bias. This data is linked to the second wave of the Donor InSight survey (DIS-II; 2012-2013, N = 34826, for details see Timmer et al. (2019)), which provides extensive information on donors' socio-demographic characteristics (e.g., age, gender) as well as their potential motivations for compliance (e.g., talking about donations, altruistic values). The unit of observation are all solicitations in 2012 and 2013 that were sent out to donors that participated in the DIS-II survey.

Our analysis involves three levels (see Figure 4.1): the level of solicitations, the level of individual donors, and the level of the collection sites. Donors almost always donate at the same collection sites (close to where they live or work). Hence, we assign donors to the collection site that they received the most solicitations for in 2012 and 2013 to obtain a clear hierarchical data structure. Below, we provide a list of the measured variables and the latent constructs (and scales used to measure these) that are used in our analysis. Table 4.1 provides descriptive statistics for the study measures.

### 4.3.1 Dependent variable

Compliance with a solicitation for a blood donation is a binary variable derived from the blood bank information system. For each solicitation, we track a donor's compliance four weeks after they have received a solicitation. Thus, the variable takes the value 1 if a donation was made within four weeks after receiving a solicitation, and the value 0 otherwise. In this way, we capture compliance even if a donor comes to donate slightly before or after the period or date stated on the solicitation letter. For several reasons that are unrelated to the intention to donate, such as low haemoglobin levels, blood donations might be unsuccessful. Thus, donation attempts capture individuals' prosocial behaviour better than only successful donations.

The data shows that about 57% of solicitations were followed by a donation attempt (see Table 4.1). This reveals lots of potential for improving compliance rates. The data further shows that there is large variation in compliance rates on the individual level (Figure 4.3 A), and the collection site level (Figure 4.3 B). The compliance rate at mobile collection

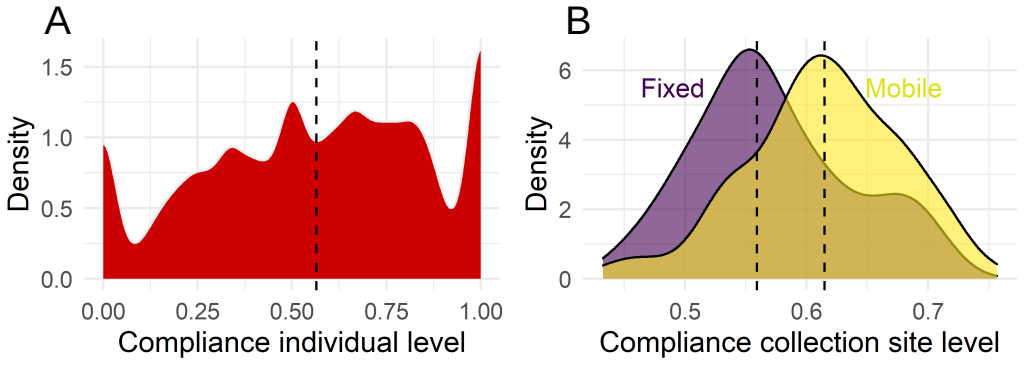


**Figure 4.3** Compliance with solicitations for whole blood donations in 2012 and 2013. Panel A: Compliance on the individual level, N = 24016 individuals. Panel B: Compliance on the collection site level, N = 164 collection sites.
Notes: The dashed lines indicate the means of each distribution.

sites (61%) is slightly higher in comparison to the compliance rate at fixed collection sites (56%).

### 4.3.2 Predictors of interest

Word of mouth (WOM) recruitment is a binary variable indicating whether donors report that they were initially recruited via WOM. The recruitment channel was elicited with the question 'What made you decide to become a donor?', and the response options were '(1) own idea, (2) brochure from the blood bank, (3) recruitment activities of the blood bank, (4) newspaper, (5) internet, (6) partner, (7) family, (8) friends or acquaintances, and (9) other', where multiple response options could be selected. WOM recruitment takes the value 1 if the respondent selected at least one of the options 6, 7, or 8, and the value 0 otherwise. Since multiple response options could be selected in the survey, the recruitment channels are not mutually exclusive. Our main analysis uses the variable described above indicating whether a donor was recruited via WOM, potentially among other influences on recruitment. As a robustness check, we also constructed a variable indicating whether a donor was only recruited via WOM. The results are reported in Appendix Table A4.7, and do not substantially differ from those in our main analysis.

To measure talking about donations, DIS-II participants were asked: 'How often do you speak with people in your circle of acquaintances about blood donation?', and response options were 'never', 'occasionally', 'regularly', and 'often', which were coded as 1-4.

Conceptually, WOM recruitment and talking about donations are not necessarily related. WOM recruitment refers to the way donors came to the initial decision about registering with the blood bank. Talking about donations, in contrast, is about how much people

**Table 4.1** Descriptive statistics of study measures

| Variable | Mean | SD | Min. | Max. | N |
|---|---|---|---|---|---|
| *Solicitation level* | | | | | |
| Compliance | 0.572 | 0.495 | 0 | 1 | 157017 |
| *Individual level* | | | | | |
| WOM recruitment | 0.458 | 0.498 | 0 | 1 | 23862 |
| Talking about donations | 2.011 | 0.471 | 1 | 4 | 24016 |
| Working hours | 26.604 | 16.116 | 0 | 99 | 22883 |
| Having children | 0.735 | 0.442 | 0 | 1 | 24045 |
| GST | 3.413 | 0.712 | 1 | 5 | 23972 |
| Altruistic values | 3.685 | 0.693 | 1 | 5 | 23967 |
| Awareness of need | 4.635 | 0.624 | 1 | 5 | 24001 |
| Affective attitudes | 3.677 | 0.769 | 1 | 5 | 23597 |
| Satisfaction with blood bank | 4.437 | 0.553 | 1 | 5 | 24015 |
| More solicitations | 0.138 | 0.345 | 0 | 1 | 23953 |
| Less solicitations | 0.024 | 0.152 | 0 | 1 | 23953 |
| Age | 48.176 | 12.989 | 18 | 71 | 24045 |
| Male | 0.443 | 0.497 | 0 | 1 | 24045 |
| Previous donations | 32.689 | 26.736 | 1 | 256 | 24045 |
| Common blood type | 0.674 | 0.469 | 0 | 1 | 24044 |
| Rare blood type | 0.195 | 0.396 | 0 | 1 | 24044 |
| Universal blood type | 0.131 | 0.337 | 0 | 1 | 24044 |
| *Collection site level* | | | | | |
| Mobile | 0.652 | 0.478 | 0 | 1 | 164 |

Notes: Values for latent constructs (GST, altruistic values, awareness of need, affective attitudes, and satisfaction with the blood bank) are mean-scores based on the underlying items.

speak with their entire circle of acquaintances about blood donations at the time of taking the survey. As such, the two predictors differ conceptually, but also with respect to time. For many donors, the initial decision to register as a blood donor will have taken place years ago. Having been recruited via WOM does therefore not say much about the level of talking about donations in subsequent years. This is also shown by a weak correlation between these two variables in the data (with a Pearson correlation coefficient r = 0.02, see Appendix Table A4.3).

### 4.3.3 Moderators

Experience as a blood donor is measured by the overall number of donations recorded in the blood bank information system up to the date of response to the DIS-II survey.

Altruistic values are measured using a 5-point Likert scale based on three items. The items originate in the Survey of Interpersonal Values (SIV) by Gordon, and were translated into Dutch by Drenth & Kranendonk (1973) (cited in Merz, van den Hurk, and de Kort 2017). The items are: 'I try to work towards the wellbeing of society.', 'It is important to me

that I help others.', and 'I think it is important to help the poor and the needy.'.

Mobile is a binary variable on the collection site level derived from Sanquin records that takes the value 1 if a collection site was mobile, and 0 otherwise.

### 4.3.4 Covariates

There are three groups of factors that have been shown to affect the decision-making process about compliance, and that are likely also related to WOM recruitment and to talking about donations. They are thus (potential) confounders of the relationship between WOM recruitment or talking about donations and compliance with solicitations for donations. We therefore consider them as covariates. Below, we describe the measurement of the covariates. Section 4.4 describes how these variables are included in the statistical models.

First, because blood donations require time-investment, there are opportunity costs of compliance (Freeman 1997; Merz, Zijlstra, and de Kort 2017). We include weekly working hours and having children (no = 0, yes = 1) as two indicators for these costs.

Second, several values have been shown to affect prosocial behaviour more generally, among them awareness of need, generalized social trust (GST), and altruistic values (Bekkers and Wiepking 2011). There is no established scale to measure awareness of need for blood donations, but it has been identified as a central factor motivating charitable giving (Bekkers and Wiepking 2011), and it is also among frequently self-reported motivations for donating blood (Ferguson et al. 2020). We therefore use the responses to the item 'My blood is needed.' on a five-point scale ranging from 'totally disagree' to 'totally agree' to measure awareness of need for blood donations. Our measure of generalised social trust (GST) was originally developed by Rosenberg (1956), and adapted by Bekkers (Bekkers 2003). GST is measured using a 5-point Likert scale based on two items: 'In general, most people can be trusted.', and 'You cannot be careful enough when you are dealing with other people.'.

Third, blood donation specific attitudes affect compliance. Satisfaction with the blood bank is a central influence on blood donation intentions (Martín-Santana et al. 2021) but not self-reported compliance with invitations to donate (Merz, Zijlstra, and de Kort 2017). Following Merz, Zijlstra, and de Kort (2017), we measure satisfaction with the blood bank using the following four items measured on a five-point Likert scale ranging from 'totally disagree' to 'totally agree': 'I think the blood bank is a professional organization.', 'There is sufficient opportunity to ask questions at the blood bank.', 'I am convinced that the blood bank treats my personal information with care.', 'I am approached personally at the blood bank.'. Affective attitude towards blood donation is a variable from the extended Theory of Planned Behavior (TPB) (Ajzen 1991) that has been adapted to the blood donation context (Veldhuizen et al. 2011). Affective attitude was elicited using a 5-point semantic-differential scale including three statements in response to the statement 'I find giving blood...': 'pleasant – unpleasant', 'annoying – enjoyable', and 'unappealing – appealing'. A

perception of receiving too few or too many solicitations likely affects donors' motivation to comply (van Diepen et al. 2009). To measure the feeling of receiving too few or too many invitations, participants were asked: 'Are you satisfied with the number of times per year that you receive an invitation to donate or are able to make an appointment to donate?', where response options were 'yes', 'no, I would like to receive an invitation/make an appointment more often', and 'no, I would like to receive an invitation/make an appointment less often', and 'no opinion/not applicable'. We create a binary variable indicating whether a donor wants more solicitations, and another binary variable indicating whether a donor wants less solicitations.

As further sociodemographic covariates we include age in years, and being male (no = 0, yes = 1). Finally, we include a measure for the blood type, because the frequency of receiving solicitations depends on the blood type. Blood type is included in the three categories 'rare blood type' (B+, AB+, A-, B-, AB-), 'common blood type' (0+, A+), and 'universal blood type' (0-).

## 4.4 Methods

This study was approved by the Research Ethics Review Committee (RERC) of the Faculty of Social Sciences, Vrije Universiteit Amsterdam [reference number RERC/18-10-08]. The Donor InSight study was approved by the Medical Ethical Committee Arnhem-Nijmegen in the Netherlands [CMO-nr: 2005/119]. All participants gave their written, informed consent.

We registered our hypotheses and an analysis plan at the Open Science Framework: https:// doi.org/10.17605/OSF.IO/H9SW6. As of the date of registration, both data sets existed and were accessible to the authors. However, the dependent variable had not been constructed, and no analyses had been conducted in relation to the hypotheses of this study. The authors' prior knowledge about the data are described in more detail in the registration. The R and Stata code used in the analysis are available at the OSF project page: https://osf.io/zbxe4/.

In our empirical analysis, we use a three-level structural equation model with a probit regression in the structural model. The three levels are the solicitations, the donors, and the collection sites. To estimate level-specific effects of variables on level 2 and level 3 (there are no level 1 predictors), we group-mean center the level 2 variables, and include the group-means for variables of interest as predictors on level 3 (Brincks et al. 2017; Enders and Tofighi 2007).

We first estimate a model including the covariates likely to be confounders of the relationship between WOM recruitment (H1a) or talking about donations (H2a) and compliance with solicitations. On the individual level, these are experience as a blood donor,

GST, blood type, working hours, age, sex, and having children. On the collection site level, these are the sociodemographic characteristics average age, proportion of males, average experience, and whether a collection site is mobile or fixed.

In the second model, we add variables that might be confounders, but that could alternatively be mediators (and in the latter case should not be included as covariates). On the individual level, we additionally include affective attitudes, awareness of need, wanting more or less invitations, and satisfaction with the blood bank. On the collection site level, we further include wanting less/more solicitations and satisfaction with the blood bank as covariates. Below, we focus on the results from Model 2 to account for potential additional confounders, but results for the variables of interest do not differ substantially between Models 1 and 2 (see Appendix Table A4.1). In the third model, we add the interaction term between talking about donations and altruistic values to test hypothesis 4. Because the possibility to estimate an interaction using latent variables in a three-level model was not integrated in Mplus version 8.0, we use mean-scores for altruistic values in place of the latent variable to test this hypothesis.

In the fourth model, we extend model 2 to include the interaction term between talking about donations and the mobile collection site dummy to test hypothesis 3. We further include a random slope for talking about donations (Heisig and Schaeffer 2019).

We use Bayesian inference with Markov Chain Monte Carlo (MCMC) estimation in Mplus version 8 (Muthén and Muthén 2017) via the MplusAutomation package (Hallquist and Wiley 2018) for R (R Core Team 2021). MCMC estimation enables the estimation of a three-level structural equation model with a binary dependent variable and latent independent variables. Our estimation used 4 chains and the default priors used by Mplus (Muthén and Muthén 2017). Chains were run for a minimum of 20000 iterations, and until convergence was achieved as indicated by all parameters having a potential scale reduction factor (PSRF) lower than 1.05 (Gelman and Rubin 1992). Convergence of the models was further assessed by inspecting trace plots and autocorrelation plots. The first half of iterations was discarded for burn-in.

We calculate average marginal effects (AMEs) for the variables of interest to be able to assess the strength of association on the probability scale. To do so, we re-estimate the models using unit-weighted mean-scores instead of the latent variables and maximum likelihood (ML) estimation in Stata version 16 (StataCorp. 2019). We compare the probit coefficients between the two approaches to confirm that results are robust to different estimation procedures (see Appendix Tables A4.1 and A4.2). The results are substantially the same, which makes us confident that neither the use of listwise deletion and mean-scores instead of latent variables (two limitations of the ML-estimation) or uncertainty about convergence (a limitation of the MCMC estimation) affect our results.

Below, the abbreviation 95% CI refers to 95% credible intervals when referring to results based on Bayesian MCMC estimation, and to 95% confidence intervals, when refer-

ring to results based on ML estimation.

## 4.5 Results

We hypothesised that compliance will be higher for donors that are recruited via WOM (H1a), and for donors that talk more about blood donations (H2a), and that compliance rates will be higher at collection sites with a higher proportion of donors recruited via WOM (H1b), and with a higher average level of talking about donations (H2b). Figure 4.4 shows the level of compliance differentiated by recruitment via word of mouth and by the level of talking about donations. On the individual level, there is almost no difference between the compliance rate of donors that were recruited via WOM and those that were recruited via other channels (see Figure 4.4 A). In contrast, there is a clear positive bivariate association between compliance and the level of talking about donations (see Figure 4.4 B). Donors that never talk about blood donations have about a 50% compliance, donors that occasionally talk about blood donations have about a 59% compliance, donors that regularly talk about donations have about a 67% compliance, and the very small group of donors that often talk about blood donations have about a 59% compliance with solicitations for donations.

A similar picture emerges on the collection site level. We do not see an association between the level of compliance and the proportion of donors recruited via WOM (Figure 4.4 C), while there is a clear positive bivariate association between the compliance rate and the level of talking about donations (Figure 4.4 D).

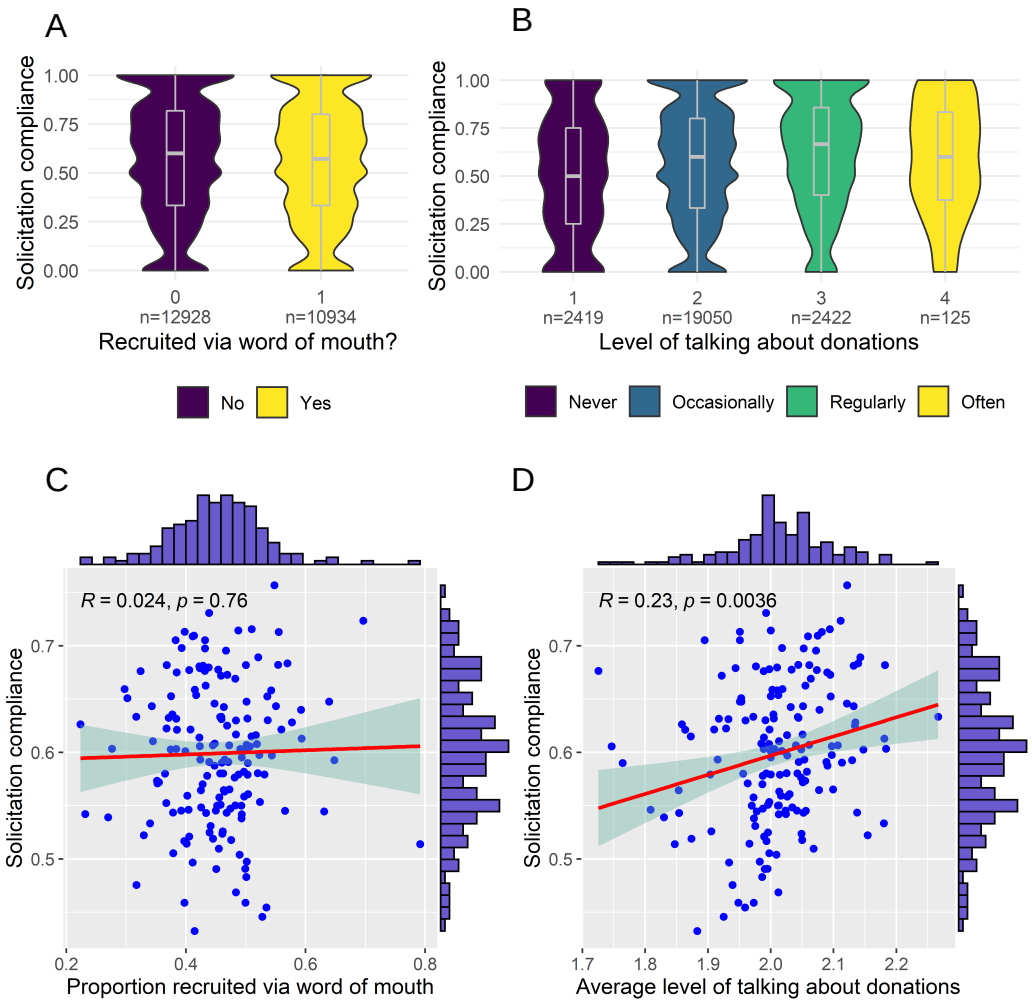


**Figure 4.4** Level of compliance by recruitment via word of mouth and by the level of talking about donations on the individual level and the collection-site level. Panel A: Level of compliance for donors that were recruited via WOM or not, N = 23 862, missing = 183. Panel B: Level of compliance by level of talking about donations, N = 24 016, missing = 29. Panel C: Level of compliance by WOM recruitment on collection site level, N = 164. Panel D: Level of compliance by level of talking about donations on collection site level, N = 164.

### 4.5.1 Results of statistical models

Results of the statistical models are shown in Appendix Table A4.1 (MCMC estimation) and Appendix Table A4.2 (ML estimation), and average marginal effects are depicted in Figure 4.5. As outlined in section 4.4, we focus on Model 2 for the test of hypotheses 1, 2, and 5, and Models 3 and 4 for the test of hypotheses 3 and 4.

#### Perception of the social context

In line with the descriptive statistics, the model estimates that the association between WOM recruitment and compliance is essentially zero (b = -0.001, 95% CI = -0.023, 0.020), as also shown by the AME of zero (see Figure 4.5). Donors that were recruited via WOM are therefore not more likely to comply than donors that signed up on their own initiative or those that were recruited by the blood bank. Hypothesis 1a is thus not supported by the data.

Talking about donations is positively associated with compliance (b = 0.083, 95% CI = 0.061, 0.106). Donors that are one unit higher on the measure of talking about donations are estimated to have a 2.9 percentage points higher probability of compliance with a solicitation for a donation, net of other key determinants of compliance behaviour (see Figure 4.5). This is in line with hypothesis 2a.

On the collection site level, both WOM recruitment (b = 0.206, 95% CI = -0.174, 0.578) and talking about donations (b = 0.264, 95% CI = -0.077, 0.603) are most likely positively associated with compliance, but both positive and smaller negative associations are plausible. Hypotheses 1b and 2b are therefore not sufficiently supported by the data.

#### Evaluation of the context

Model 4 in Appendix Table A4.1 shows the results for hypothesis 3, which stated that the individual-level association between talking about donations and compliance should be stronger at mobile than fixed collection sites. However, we do not find substantial variation in the association between talking about donations and compliance across collection sites (see Appendix Figure A4.2); a likelihood-ratio test reveals that the inclusion of a random slope for talking about donations does not substantially increase the model fit ($\chi^2$ (1) = 0.17, p = 0.685). The posterior distribution of the estimate for the cross-level interaction provides some support for the positive interaction (b = 0.025, 95% CI = -0.029, 0.077), but also shows that both negative and positive interactions are plausible based on our data. Hypothesis 3 is therefore not supported by the data.

With Hypothesis 4 we hypothesised that the association between talking about donations and compliance might be stronger for those with lower altruistic values. The results of model 3 show the expected negative interaction (see Appendix Figure A4.1), but the 95%

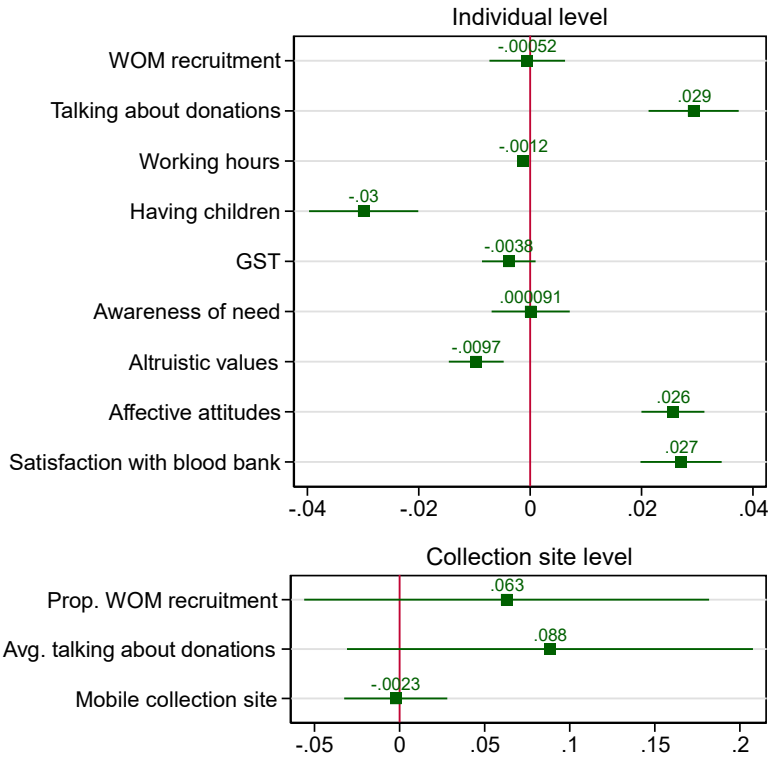


**Figure 4.5** Coefficient plot of average marginal effects (AMEs) on the probability of compliance with a solicitation for a donation.
Notes: AMEs are based on model 2 in Appendix Table A4.2.

credibility interval indicates that no interaction effect or a positive interaction effect are also plausible (b = -.018, 95% CI = -0.049, 0.012). Hypothesis 4 is therefore not supported by the data.

### Selection of behaviour

Hypothesis 5 stated that the association between talking about donations and compliance should be weaker for more experienced donors. This hypothesis is supported by the negative interaction effect between talking about donations and the number of previous donations (b = -.001, 95% CI = -0.002, -0.001). For the least experienced donors, a one-unit increase in talking about donations is predicted to increase the probability of compliance by about 5 percentage points (see Figure 4.6). For donors with more experience, in contrast, the average marginal effect of talking about donations is much smaller, and even turns negative for the very few donors with a very large number of previous donations.

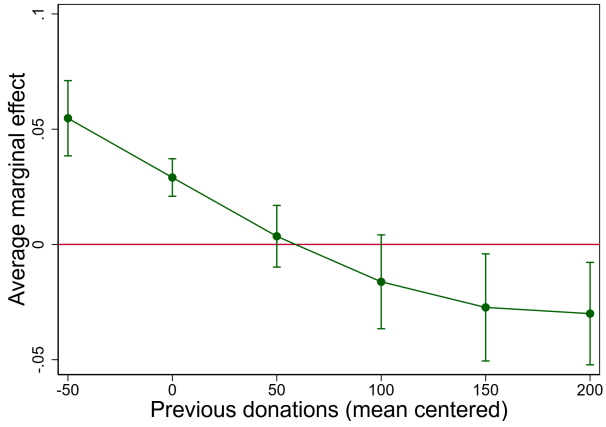


**Figure 4.6** Average marginal effect of talking about donations with 95% CI by level of experience as a blood donor.
Notes: AMEs are based on model 2 in Appendix Table A4.2.

### 4.5.2 Robustness checks and exploratory analyses

We conducted the following non-registered robustness checks and exploratory analyses to assess the reliability of our results and provide further insights into what might drive compliance with solicitations for donations.

#### Robustness checks

A concern regarding our result for hypothesis 2a might be simultaneity; i.e., reciprocal causation between talking about donations and compliance. Our data does not allow us to cleanly disentangle these two aspects, and it is not the goal of this study to provide an estimate for the causal effect of talking about donations on compliance. However, we can provide two pieces of evidence that talking about donations has predictive power with regards to compliance. First, we re-estimate Model 2 using a restricted sample of donors that participated in the survey in 2012 and using compliance in 2013 as the dependent variable (see Appendix Table A4.6 Model 1). That is, we regress compliance in 2013 on talking about donations in 2012. The estimate from this approach is similar, albeit smaller than the one from our main analysis. A one-unit increase in talking about donations is associated with a 1.7 percentage point increase in the probability of compliance (b = 0.051, 95% CI = 0.015, 0.087, AME = 0.017). This test does not provide a strict test of causality since it does not rule out that talking about donations is affected by prior levels of compliance to some extent. It does however show, that talking about donations can be used to predict compliance in the future. Second, to further assess the question of causality, we re-estimate Model 2 in a restricted sample of donors that did not make any donations prior to participating in

the DIS-II survey (see Appendix Table A4.6 Model 2). For these donors, the extent to which they talk about donations should be exogenous with respect to compliance, since they do not yet have a level of compliance. This subsample is small, including only 642 donors, so statistical power is low. However, the estimate for the association between talking about donations and compliance in the following years is also positive and similar in size to the one using the lagged talking about donations specification, but the confidence interval does include zero (b = 0.056, 95% CI = -0.102, 0.214, AME = 0.019).

Next, taking account of recent recommendations to use linear models for the analysis of binary outcomes (Gomila 2021), we further show the robustness of our results to using a multilevel linear probability model (Appendix Table A4.4) and OLS regression with standard errors clustered at the collection site level (Appendix Table A4.5).

Finally, we show that our results for the association between WOM recruitment and compliance are robust to an alternative construction of the WOM recruitment variable described in section 3.2. (see Appendix Table A4.7 Model 1), and that the association between talking about donations and compliance is robust to the exclusion of those who 'often' talk about blood donations, which might be employees of the blood bank (see Appendix Table A4.7 Model 2).

**Results from exploratory analyses**

Our models also reveal interesting results for factors that were identified as potentially important to compliance with solicitations for donations based on previous literature (see Figure 4.5). First, potential costs of compliance, such as higher working hours (b = -0.004, 95% CI = -0.005, -0.003) and having children (b = -0.095, 95% CI = -0.122, -0.068), show an expected negative association with the probability of compliance. Next, general values often associated with prosocial behaviour do not seem to predict compliance well. Neither awareness of need (b = -0.003, 95% CI = -0.021, 0.015) nor GST (b = -0.017, 95% CI = -0.038, 0.002) are strongly associated with the probability of compliance. Altruistic values are even negatively associated with compliance (b = -0.058, 95% CI = -0.088, -0.028). Finally, blood donation specific attitudes show strong positive associations with compliance behaviour. A donor one unit higher on affective attitudes is predicted to have a 2.6 percentage points higher compliance (b = 0.087, 95% CI = 0.071, 0.104; AME = 0.026), and a donor that is one unit higher on satisfaction with the blood bank is predicted to have a 2.7 percentage points higher compliance with solicitations for donations (b = 0.105, 95% CI = 0.078, 0.133; AME = 0.027). Finally, we assessed whether WOM recruitment, like talking about donations, might be more relevant for the compliance of novice donors. However, this interaction effect was not supported by the data (b = 0.000, 95% CI = -0.000, 0.001).

## 4.6 Discussion and conclusions

This study has analysed to what extent compliance with solicitations for blood donations is related to talking about donations and WOM recruitment at both the individual and the collection site level. Our results show that higher talking about donations indeed predicts higher compliance. This association was moderated by donor experience, such that it is strongest for novice donors with few previous donations. Conversely, being recruited via WOM did not predict higher compliance. In addition, our data did not support the hypotheses that talking about donations and WOM recruitment explain compliance rates on the collection site level.

We developed and tested a SES model of compliance, where a donor's decision-making process consists of the perception of their social and physical environment, the evaluation of new information, and the selection and execution of a behaviour. Based on our results, talking about donations emerged as an important component of a donors' perception of their social environment that is predictive of their compliance behaviour. This is in line with previous literature showing that contributions to public goods are higher in experimental settings where (potential) contributors can communicate (Balliet 2010; Simpson and Willer 2015). Our study extends this literature in two ways: First, our results suggest that it is the individual perception of the context via talking about donations that is pivotal for compliance rather than the broader social context. On the level of collection sites, which pose a relevant social and physical context for blood donations, differences in compliance rates do not seem to be explained by differences in WOM recruitment in talking about donations when the socio-demographic composition of the donor population is taken into account. Other social contexts, such as individuals' social networks, might instead be more relevant for compliance behaviour. Second, our study shows that the importance of communication translates to the case of compliance with solicitations for donations rather than general prosocial behaviour.

Regarding evaluation of the social context, our data did not support the hypothesis that the association between talking about donations and compliance is stronger at mobile collection sites, where donors are more likely to interact with others that are socially close to them. Talking about donations might therefore capture more general communication with other social network members rather than the immediate communication with others donors at the point of making a donation. Further, we do not find conclusive evidence that the evaluation depends on individuals' altruistic values. Based on our data, negative interaction effects but also small positive interaction effects are plausible. The crucial difference to previous studies of this interaction (Feinberg et al. 2012; Simpson and Willer 2008) is our focus on compliance rather than general prosocial behaviour: blood donors self-select into being a blood donor based on their altruistic values (Evans and Ferguson 2014),

and hence there is limited variation in donors' altruistic values, and altruistic values are overall negatively associated with compliance.

Regarding the process of selecting a behaviour, we find support for predictions derived from theories of habit formation in blood donor behaviour (Bruhin et al. 2019; Charng et al. 1988; Masser et al. 2008): the interaction effect between talking about donations and experience as a blood donor indicates that talking about donations is particularly important for novice donors.

Being recruited via WOM, on the other hand, does not seem to be an element of donors' perception that influences their compliance behaviour. For many donors, the recruitment process may already be too far in the past to be relevant for their contemporary compliance behaviour. For example, they might no longer be in contact with the person(s) that motivated them to become a donor, and therefore no longer be subject to their social influence. Our data, however, does not indicate that WOM recruitment results in higher compliance of novice donors.

### 4.6.1 Implications

The primary contributions of our study to theory are to recognise solicitations for donations as a distinct level of analysis, and to demonstrate the social embedding of the donors' decision-making processes about compliance with such solicitations. Much of the prosocial behaviour we observe in the real world is the result of compliance with solicitations for donations rather than spontaneous giving. A shift in focus on compliance rather than general prosocial behaviour can therefore be useful to more accurately capture how decisions about contributions to public goods are made. The application of a SES model is a further step towards a better understanding of these decisions. For example, our SES model allows us to examine how talking about donations is an important feature linking the donors decision-making process to their social environment, while maintaining a comprehensive micro-level framework for understanding the human decision-making process. The importance of the distinction between compliance and prosocial behaviour in general is further highlighted by evident dissimilarities in factors associated with compliance versus general prosocial behaviour. Our analysis shows that values often seen as conductive to prosocial behaviour, namely awareness of need, generalised social trust and altruistic values, are not necessarily associated with an individual's compliance with solicitations for donations. Our speculative interpretation of these findings is that these factors do not play a large role for compliance because blood donors already self-select into becoming a donor based on these values.

A practical implication of our findings relates to the organisations that are dependent on the effectiveness of solicitations for donations, and blood banks in particular. Blood has a limited shelf life and demand is changing continuously. Knowing about the factors

that determine compliance with solicitations is therefore essential to ensure a sufficient blood stock. Our results imply that increasing talking about blood donations among current donors could be one tool to increase the effectiveness of solicitations for donations. One strategy to achieve that may be group-donation programmes (Sun et al. 2019), where donors form groups that they can communicate and donate with  a promising area for future research. Such groups should create some actual feeling of relatedness, as previous studies have shown that social influence is at work among closely related individuals (Bruhin et al. 2020; Meyer and Tripodi 2021; Schröder et al. 2023), but not among distant peers (Goette and Tripodi 2024). Finally, promoting communication about donations might be particularly effective for donors in early stages of their donor career, since their behaviour is more malleable than that of very experienced donors.

### 4.6.2 Limitations

The main limitation of our study is that its results cannot be interpreted causally. There are two main threats to a causal interpretation: First, it might be that individuals that talk more about donations have a higher compliance due to unobserved confounders. And second, it is likely that talking about donations is partly caused by compliance. For example, reputational concerns could mean that individuals are more likely to talk about donations when they generally comply with solicitations than when they do not. We have conducted two robustness checks which alleviate the implications of these concerns for practice, as they show that talking about donations is predictive of future compliance. Blood banks could either implement strategies that increase communication about blood donations to achieve higher compliance, or strategies that target recruitment at donors that are more likely to talk about donations in the first place.

Another limitation of our study is that we do not have insights into the potential mechanisms of social influence that might explain an effect of talking about donations on compliance. Previous research suggests that information about need, descriptive norms, and group identities might be underlying mechanisms (Balliet 2010; Simpson and Willer 2015), but we cannot differentiate between these mechanisms in this study.

### 4.6.3 Directions for future research

An important direction for future research is to provide causal evidence on the effect of increased opportunities for communication on compliance behaviour. This includes research on its potentially reciprocal causation with compliance, the mechanisms that talking about donations might operate through, and the most effective ways to implement the findings of this research into practice via corresponding retention strategies.

Another important contribution of future research could be a complete analysis of the

SES model suggested in this article. This article has focussed on how individual behaviour is shaped by the social context, but another important question in SES analysis is how the social and physical context emerges from the behavioural choices of individuals. This question is particularly relevant when considering processes of social influence in the long run, because there will be reciprocal causality between individual's decision and the social context, in this case the decisions and attitudes of other people.

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# Appendix A4

**Appendix Table A4.1** Three-level structural equation model: regression of compliance on individual and collection site characteristics.

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI |
| *Individual level* | | | | | | | | |
| Word-of-mouth recruitment | -0.006 | [-0.028,0.015] | -0.001 | [-0.023,0.020] | -0.002 | [-0.023,0.020] | -0.001 | [-0.023,0.020] |
| Talking about donations | 0.117 | [0.095,0.140] | 0.083 | [0.061,0.106] | 0.084 | [0.061,0.106] | 0.080 | [0.049,0.110] |
| Experience | 0.007 | [0.007,0.008] | 0.007 | [0.006,0.007] | 0.007 | [0.006,0.007] | 0.007 | [0.006,0.007] |
| Talking*Experience | -0.001 | [-0.002,-0.001] | -0.001 | [-0.002,-0.001] | -0.001 | [-0.002,-0.001] | -0.001 | [-0.002,-0.001] |
| GST | -0.017 | [-0.034,-0.001] | -0.017 | [-0.038,0.002] | -0.046 | [-0.086,-0.006] | -0.018 | [-0.040,0.001] |
| Altruistic values | -0.025 | [-0.055,0.005] | -0.058 | [-0.088,-0.028] | -0.032 | [-0.048,-0.017] | -0.058 | [-0.089,-0.028] |
| Talking*Altr. values | | | | | -0.018 | [-0.049,0.012] | | |
| Working hours | -0.004 | [-0.005,-0.003] | -0.004 | [-0.005,-0.003] | -0.004 | [-0.005,-0.003] | -0.004 | [-0.005,-0.003] |
| Age | 0.006 | [0.004,0.007] | 0.006 | [0.005,0.007] | 0.006 | [0.005,0.007] | 0.006 | [0.005,0.007] |
| Male | 0.041 | [0.016,0.066] | 0.053 | [0.028,0.078] | 0.052 | [0.027,0.078] | 0.053 | [0.028,0.078] |
| Having children | -0.098 | [-0.125,-0.071] | -0.095 | [-0.122,-0.068] | -0.095 | [-0.121,-0.068] | -0.095 | [-0.122,-0.068] |
| Rare blood type | 0.024 | [-0.004,0.051] | 0.021 | [-0.007,0.048] | 0.021 | [-0.006,0.049] | 0.022 | [-0.006,0.049] |
| Universal blood type | 0.005 | [-0.025,0.036] | 0.002 | [-0.028,0.033] | 0.003 | [-0.028,0.033] | 0.002 | [-0.028,0.033] |
| Awareness of need | | | -0.003 | [-0.021,0.015] | -0.004 | [-0.022,0.015] | -0.003 | [-0.022,0.015] |
| Affective attitudes | | | 0.087 | [0.071,0.104] | 0.090 | [0.073,0.107] | 0.087 | [0.071,0.104] |
| Satisfaction with the BB | | | 0.105 | [0.078,0.133] | 0.100 | [0.074,0.127] | 0.105 | [0.079,0.132] |
| Wants more solicitations | | | 0.089 | [0.057,0.121] | 0.089 | [0.057,0.121] | 0.089 | [0.057,0.121] |
| Wants less solicitations | | | -0.432 | [-0.499,-0.364] | -0.430 | [-0.498,-0.362] | -0.432 | [-0.500,-0.365] |
| *Collection site level* | | | | | | | | |
| Prop. word-of-mouth recrt. | 0.301 | [-0.086,0.695] | 0.206 | [-0.174,0.578] | 0.199 | [-0.181,0.577] | 0.204 | [-0.179,0.583] |
| Avg. talking about donations | 0.403 | [0.052,0.750] | 0.264 | [-0.077,0.603] | 0.260 | [-0.084,0.601] | 0.269 | [-0.078,0.613] |
| Mobile | 0.019 | [-0.049; 0.087] | 0.008 | [-0.076; 0.093] | 0.006 | [-0.076,0.090] | 0.010 | [-0.072,0.095] |
| Avg. age | 0.037 | [ 0.024; 0.050] | 0.030 | [ 0.016; 0.043] | 0.030 | [0.017,0.043] | 0.030 | [0.016,0.043] |
| Prop. male | 0.826 | [0.461; 1.182] | 0.761 | [0.410; 1.108] | 0.768 | [0.416,1.112] | 0.756 | [0.405,1.105] |
| Avg. Experience | -0.011 | [-0.016; -0.005] | -0.010 | [-0.015; -0.004] | -0.010 | [-0.015,-0.004] | -0.009 | [-0.015,-0.004] |
| Prop. want more solicitations | | | -0.136 | [-0.548; 0.271] | -0.131 | [-0.547,0.281] | -0.145 | [-0.562,0.270] |
| Prop. Want less solicitations | | | -2.429 | [-3.831; -1.004] | -2.447 | [-3.853,-1.016] | -2.434 | [-3.846,-0.995] |
| Avg. Satisfaction with BB | | | 0.606 | [-0.288,1.676] | 0.609 | [-0.284,1.668] | 0.631 | [-0.251,1.719] |
| Talking*Mobile | | | | | | | 0.025 | [-0.029,0.077] |
| Constant | -2.556 | [-3.411; -1.678] | -1.811 | [-2.720,-0.891] | -1.807 | [-2.714,-0.885] | -1.807 | [-2.713,-0.890] |
| *N* | 156679 | | 156679 | | 156679 | | 156679 | |

Notes: Coefficients are the median of the posterior distribution. 95% CI = 95% credible intervals (in brackets).

**Appendix Table A4.2** Three-level probit regression of compliance on individual and collection site characteristics.

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI |
| *Individual level* | | | | | | | | |
| Word-of-mouth recruitment | -0.007 | [-0.027,0.013] | -0.001 | [-0.022,0.019] | -0.001 | [-0.022,0.019] | -0.001 | [-0.022,0.019] |
| Talking about donations | 0.119*** | [0.094,0.144] | 0.087*** | [0.062,0.111] | 0.087*** | [0.063,0.112] | 0.084*** | [0.054,0.113] |
| Experience | 0.007*** | [0.006,0.008] | 0.007*** | [0.006,0.007] | 0.007*** | [0.006,0.007] | 0.007*** | [0.006,0.007] |
| Talking*Experience | -0.002*** | [-0.002,-0.001] | -0.002*** | [-0.002,-0.001] | -0.002*** | [-0.002,-0.001] | -0.002*** | [-0.002,-0.001] |
| GST | -0.025** | [-0.040,-0.009] | -0.012 | [-0.027,0.003] | -0.012 | [-0.027,0.003] | -0.012 | [-0.027,0.003] |
| Altruistic values | -0.013 | [-0.027,0.002] | -0.030*** | [-0.045,-0.015] | -0.030*** | [-0.045,-0.015] | -0.030*** | [-0.045,-0.015] |
| Talking*Altr. values | | | | | -0.012 | [-0.040,0.016] | | |
| Working hours | -0.004*** | [-0.005,-0.003] | -0.004*** | [-0.005,-0.003] | -0.004*** | [-0.005,-0.003] | -0.004*** | [-0.005,-0.003] |
| Age | 0.006*** | [0.004,0.007] | 0.006*** | [0.005,0.007] | 0.006*** | [0.005,0.007] | 0.006*** | [0.005,0.007] |
| Male | 0.046*** | [0.020,0.072] | 0.055*** | [0.030,0.081] | 0.055*** | [0.030,0.081] | 0.055*** | [0.030,0.081] |
| Having children | -0.094*** | [-0.123,-0.064] | -0.092*** | [-0.122,-0.062] | -0.092*** | [-0.122,-0.062] | -0.092*** | [-0.122,-0.062] |
| Rare blood type | 0.026 | [-0.003,0.055] | 0.024 | [-0.004,0.052] | 0.024 | [-0.004,0.052] | 0.024 | [-0.004,0.052] |
| Universal blood type | -0.005 | [-0.036,0.026] | -0.009 | [-0.039,0.021] | -0.009 | [-0.039,0.021] | -0.009 | [-0.039,0.021] |
| Awareness of need | | | 0.000 | [-0.021,0.022] | 0.000 | [-0.021,0.022] | 0.000 | [-0.021,0.022] |
| Affective attitudes | | | 0.078*** | [0.061,0.096] | 0.078*** | [0.061,0.096] | 0.078*** | [0.061,0.096] |
| Satisfaction with the BB | | | 0.083*** | [0.060,0.105] | 0.083*** | [0.060,0.105] | 0.083*** | [0.060,0.105] |
| Wants more solicitations | | | 0.091*** | [0.051,0.131] | 0.091*** | [0.051,0.131] | 0.091*** | [0.051,0.131] |
| Wants less solicitations | | | -0.423*** | [-0.489,-0.356] | -0.422*** | [-0.489,-0.356] | -0.423*** | [-0.489,-0.356] |
| *Collection site level* | | | | | | | | |
| Prop. WOM recruitment | 0.322 | [-0.047,0.690] | 0.192 | [-0.167,0.558] | 0.194 | [-0.168,0.557] | 0.196 | [-0.167,0.558] |
| Avg. talking about donations | 0.408* | [0.063,0.754] | 0.270 | [-0.095,0.635] | 0.271 | [-0.094,0.636] | 0.270 | [-0.095,0.635] |
| Mobile | 0.011 | [-0.066,0.089] | -0.005 | [-0.098,0.087] | -0.005 | [-0.097,0.087] | -0.005 | [-0.097,0.087] |
| Avg. age | 0.038*** | [0.025,0.052] | 0.031*** | [0.018,0.044] | 0.031*** | [0.018,0.044] | 0.031*** | [0.018,0.044] |
| Prop. male | 0.863*** | [0.526,1.201] | 0.829*** | [0.499,1.159] | 0.829*** | [0.499,1.159] | 0.829*** | [0.499,1.159] |
| Avg. Experience | -0.012*** | [-0.017,-0.006] | -0.010*** | [-0.016,-0.005] | -0.010*** | [-0.016,-0.005] | -0.010*** | [-0.016,-0.005] |
| Prop. want more solicitations | | | -0.153 | [-0.567,0.262] | -0.154 | [-0.568,0.261] | -0.153 | [-0.568,0.262] |
| Prop. Want less solicitations | | | -2.783*** | [-4.106,-1.459] | -2.789*** | [-4.111,-1.467] | -2.785*** | [-4.108,-1.462] |
| Avg. Satisfaction with BB | | | 0.248 | [-0.026,0.522] | 0.248 | [-0.026,0.522] | 0.248 | [-0.026,0.522] |
| Talking*Mobile | | | | | | | 0.015 | [-0.034,0.064] |
| Constant | -2.630*** | [-3.535,-1.725] | -2.987*** | [-4.272,-1.702] | -2.986*** | [-4.270,-1.702] | -2.986*** | [-4.271,-1.701] |
| *N* | 147953 | | 145343 | | 145343 | | 145343 | |

* p < 0.05, ** p < 0.01, *** p < 0.001. 95% CI = 95% confidence intervals (in brackets).

**Appendix Table A4.3** Pearson correlation coefficients among study measures on the individual level.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Compliance (1) | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| WOM recruitment (2) | -.04 | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Talking about donation (3) | .08 | .02 | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Working hours (4) | -.10 | .05 | -.02 | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Having children (5) | .07 | -.10 | -.02 | -.11 | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . |
| Generalized social trust (6) | -.04 | .00 | -.04 | .05 | .00 | 1 | . | . | . | . | . | . | . | . | . | . | . | . |
| Altruistic values (7) | .00 | -.01 | .10 | -.06 | -.01 | .13 | 1 | . | . | . | . | . | . | . | . | . | . | . |
| Awareness of need (8) | .08 | -.03 | .10 | -.05 | .10 | -.01 | .12 | 1 | . | . | . | . | . | . | . | . | . | . |
| Affective attitudes (9) | .15 | -.04 | .18 | -.06 | .05 | -.12 | .09 | .16 | 1 | . | . | . | . | . | . | . | . | . |
| Satisfaction with BB (10) | .10 | -.01 | .10 | -.04 | .04 | .03 | .16 | .36 | .23 | 1 | . | . | . | . | . | . | . | . |
| Wants more solicitations (11) | .03 | .00 | .05 | .03 | -.08 | -.03 | .01 | .02 | .11 | -.01 | 1 | . | . | . | . | . | . | . |
| Wants less solicitations (12) | -.09 | .01 | -.04 | .03 | .01 | .03 | -.01 | -.03 | -.08 | -.05 | -.06 | 1 | . | . | . | . | . | . |
| Age (13) | .22 | -.21 | .00 | -.27 | .46 | .00 | .02 | .16 | .12 | .07 | -.14 | .02 | 1 | . | . | . | . | . |
| Male (14) | .09 | -.03 | -.01 | .30 | .13 | .01 | -.08 | -.01 | .06 | -.06 | -.03 | .06 | .24 | 1 | . | . | . | . |
| Experience (15) | .25 | -.09 | .06 | -.06 | .22 | .02 | .00 | .13 | .14 | .02 | -.09 | .01 | .59 | .43 | 1 | . | . | . |
| Common blood type (16) | -.03 | .01 | -.02 | .02 | -.03 | .00 | .00 | -.05 | -.01 | .00 | -.02 | .01 | -.01 | .02 | .00 | 1 | . | . |
| Rare blood type (17) | .01 | -.01 | -.01 | -.01 | .01 | -.01 | .00 | -.02 | -.01 | -.01 | .03 | -.01 | .01 | -.01 | -.05 | -.71 | 1 | . |
| Universal blood type (18) | .02 | .00 | .04 | -.02 | .03 | .01 | .00 | .09 | .02 | .01 | -.01 | .00 | .01 | -.01 | .06 | -.56 | -.19 | 1 |

**Appendix Table A4.4** Three-level linear probability regression of compliance on individual and collection site characteristics.

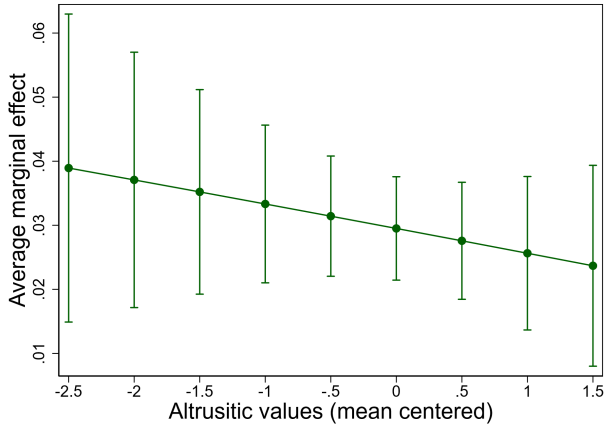
| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI |
| *Individual level* | | | | | | | | |
| Word-of-mouth recruitment | -0.002 | [-0.008,0.005] | 0.000 | [-0.007,0.007] | 0.000 | [-0.007,0.007] | 0.000 | [-0.007,0.007] |
| Talking about donations | 0.039*** | [0.031,0.047] | 0.029*** | [0.021,0.037] | 0.029*** | [0.021,0.037] | 0.028*** | [0.018,0.037] |
| Experience | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] |
| Talking*Experience | -0.001*** | [-0.001,-0.000] | -0.001*** | [-0.001,-0.000] | -0.001*** | [-0.001,-0.000] | -0.001*** | [-0.001,-0.000] |
| GST | -0.008** | [-0.013,-0.003] | -0.004 | [-0.009,0.001] | -0.004 | [-0.009,0.001] | -0.004 | [-0.009,0.001] |
| Altruistic values | -0.004 | [-0.009,0.001] | -0.009*** | [-0.014,-0.005] | -0.009*** | [-0.014,-0.005] | -0.009*** | [-0.014,-0.005] |
| Talking*Altr. values | | | | | -0.003 | [-0.012,0.006] | | |
| Working hours | -0.001*** | [-0.002,-0.001] | -0.001*** | [-0.001,-0.001] | -0.001*** | [-0.001,-0.001] | -0.001*** | [-0.001,-0.001] |
| Age | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] |
| Male | 0.014** | [0.006,0.023] | 0.017*** | [0.009,0.026] | 0.017*** | [0.009,0.026] | 0.017*** | [0.009,0.026] |
| Having children | -0.030*** | [-0.039,-0.020] | -0.029*** | [-0.039,-0.020] | -0.029*** | [-0.039,-0.020] | -0.029*** | [-0.039,-0.020] |
| Rare blood type | 0.009 | [-0.001,0.018] | 0.008 | [-0.001,0.017] | 0.008 | [-0.001,0.017] | 0.008 | [-0.001,0.017] |
| Universal blood type | -0.002 | [-0.012,0.008] | -0.003 | [-0.013,0.007] | -0.003 | [-0.013,0.007] | -0.003 | [-0.013,0.007] |
| Awareness of need | | | 0.000 | [-0.007,0.007] | 0.000 | [-0.007,0.007] | 0.000 | [-0.007,0.007] |
| Affective attitudes | | | 0.025*** | [0.020,0.031] | 0.025*** | [0.020,0.031] | 0.025*** | [0.020,0.031] |
| Satisfaction with the BB | | | 0.027*** | [0.020,0.035] | 0.027*** | [0.020,0.035] | 0.027*** | [0.020,0.035] |
| Wants more solicitations | | | 0.030*** | [0.017,0.043] | 0.030*** | [0.017,0.043] | 0.030*** | [0.017,0.043] |
| Wants less solicitations | | | -0.138*** | [-0.159,-0.118] | -0.138*** | [-0.159,-0.118] | -0.139*** | [-0.159,-0.118] |
| *Collection site level* | | | | | | | | |
| Prop. WOM recruitment | 0.106 | [-0.014,0.226] | 0.064 | [-0.054,0.183] | 0.064 | [-0.055,0.183] | 0.064 | [-0.054,0.183] |
| Avg. talking about donations | 0.134* | [0.021,0.247] | 0.086 | [-0.033,0.206] | 0.087 | [-0.033,0.206] | 0.086 | [-0.033,0.206] |
| Mobile | 0.005 | [-0.020,0.031] | 0.000 | [-0.030,0.030] | 0.000 | [-0.030,0.030] | 0.000 | [-0.030,0.030] |
| Avg. age | 0.013*** | [0.008,0.017] | 0.010*** | [0.006,0.014] | 0.010*** | [0.006,0.014] | 0.010*** | [0.006,0.014] |
| Prop. male | 0.279*** | [0.168,0.390] | 0.267*** | [0.158,0.375] | 0.267*** | [0.158,0.376] | 0.267*** | [0.158,0.375] |
| Avg. Experience | -0.004*** | [-0.006,-0.002] | -0.003*** | [-0.005,-0.002] | -0.003*** | [-0.005,-0.002] | -0.003*** | [-0.005,-0.002] |
| Prop. want more solicitations | | | -0.053 | [-0.188,0.082] | -0.053 | [-0.188,0.082] | -0.053 | [-0.188,0.082] |
| Prop. Want less solicitations | | | -0.935*** | [-1.377,-0.494] | -0.937*** | [-1.378,-0.496] | -0.936*** | [-1.378,-0.495] |
| Avg. Satisfaction with BB | | | 0.086 | [-0.005,0.177] | 0.086 | [-0.005,0.177] | 0.086 | [-0.005,0.177] |
| Talking*Mobile | | | | | | | 0.005 | [-0.011,0.021] |
| Constant | -0.361* | [-0.652,-0.070] | -0.490* | [-0.911,-0.069] | -0.490* | [-0.911,-0.069] | -0.490* | [-0.910,-0.069] |
| *N* | 147953 | | 145343 | | 145343 | | 145343 | |

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001. 95% CI = 95% confidence intervals (in brackets). Model 4 did not converge because the estimate for the random slope on talking about donations is very close to zero. It is therefore estimated using the expectation-maximization (EM) algorithm with 200 iterations.

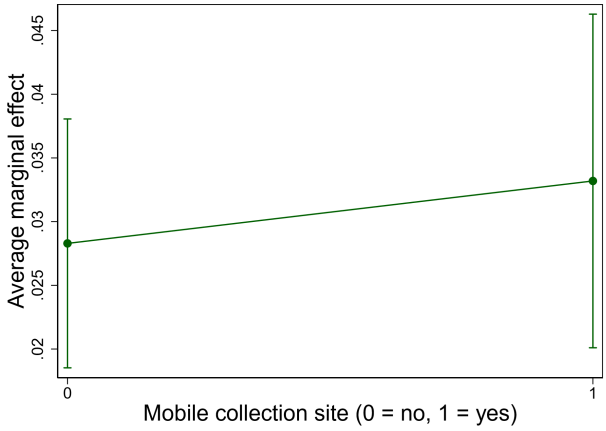
**Appendix Table A4.5** OLS regression of compliance on individual and collection site characteristics.

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI | Coef. | 95 % CI |
| *Individual level* | | | | | | | | |
| Word-of-mouth recruitment | -0.003 | [-0.009,0.004] | -0.000 | [-0.007,0.007] | -0.000 | [-0.007,0.007] | -0.000 | [-0.007,0.007] |
| Talking about donations | 0.036*** | [0.028,0.044] | 0.026*** | [0.018,0.035] | 0.026*** | [0.018,0.035] | 0.025*** | [0.015,0.034] |
| Experience | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] |
| Talking*Experience | -0.001*** | [-0.001,-0.000] | -0.001*** | [-0.001,-0.000] | -0.001*** | [-0.001,-0.000] | -0.001*** | [-0.001,-0.000] |
| GST | -0.007** | [-0.013,-0.002] | -0.003 | [-0.008,0.002] | -0.003 | [-0.009,0.002] | -0.003 | [-0.009,0.002] |
| Altruistic values | -0.003 | [-0.008,0.002] | -0.008** | [-0.013,-0.003] | -0.008** | [-0.014,-0.003] | -0.008** | [-0.014,-0.003] |
| Talking*Altr. values | | | | | -0.002 | [-0.013,0.009] | | |
| Working hours | -0.001*** | [-0.002,-0.001] | -0.001*** | [-0.002,-0.001] | -0.001*** | [-0.001,-0.001] | -0.001*** | [-0.001,-0.001] |
| Age | 0.002*** | [0.001,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] | 0.002*** | [0.002,0.002] |
| Male | 0.030*** | [0.021,0.039] | 0.032*** | [0.023,0.041] | 0.032*** | [0.023,0.041] | 0.032*** | [0.023,0.041] |
| Having children | -0.030*** | [-0.040,-0.021] | -0.030*** | [-0.040,-0.020] | -0.030*** | [-0.040,-0.021] | -0.030*** | [-0.040,-0.021] |
| Rare blood type | -0.006 | [-0.015,0.004] | -0.006 | [-0.015,0.003] | -0.006 | [-0.016,0.004] | -0.006 | [-0.016,0.004] |
| Universal blood type | -0.014* | [-0.025,-0.003] | -0.015** | [-0.025,-0.004] | -0.015** | [-0.025,-0.004] | -0.015** | [-0.026,-0.004] |
| Awareness of need | | | 0.000 | [-0.007,0.007] | 0.000 | [-0.007,0.007] | 0.000 | [-0.007,0.007] |
| Affective attitudes | | | 0.024*** | [0.018,0.030] | 0.024*** | [0.019,0.029] | 0.024*** | [0.019,0.029] |
| Satisfaction with the BB | | | 0.024*** | [0.017,0.031] | 0.024*** | [0.016,0.031] | 0.024*** | [0.016,0.031] |
| Wants more solicitations | | | 0.032*** | [0.018,0.046] | 0.032*** | [0.021,0.043] | 0.032*** | [0.021,0.043] |
| Wants less solicitations | | | -0.137*** | [-0.160,-0.114] | -0.137*** | [-0.160,-0.114] | -0.137*** | [-0.160,-0.114] |
| *Collection site level* | | | | | | | | |
| Prop. WOM recruitment | 0.135 | [-0.036,0.307] | 0.116 | [-0.026,0.258] | 0.116** | [0.036,0.197] | 0.116** | [0.036,0.197] |
| Avg. talking about donations | 0.198* | [0.038,0.358] | 0.129 | [-0.023,0.281] | 0.129*** | [0.053,0.206] | 0.129*** | [0.053,0.205] |
| Mobile | 0.004 | [-0.024,0.033] | -0.015 | [-0.049,0.019] | -0.015 | [-0.030,0.000] | -0.015 | [-0.030,0.000] |
| Avg. age | 0.018*** | [0.013,0.024] | 0.014*** | [0.010,0.019] | 0.014*** | [0.012,0.017] | 0.014*** | [0.012,0.017] |
| Prop. male | 0.307*** | [0.164,0.451] | 0.334*** | [0.200,0.469] | 0.334*** | [0.263,0.406] | 0.334*** | [0.263,0.406] |
| Avg. Experience | -0.004*** | [-0.007,-0.002] | -0.004*** | [-0.007,-0.002] | -0.004*** | [-0.005,-0.003] | -0.004*** | [-0.005,-0.003] |
| Prop. want more solicitations | | | 0.060 | [-0.128,0.248] | 0.060 | [-0.031,0.151] | 0.060 | [-0.031,0.151] |
| Prop. Want less solicitations | | | -1.219*** | [-1.661,-0.777] | -1.219*** | [-1.469,-0.970] | -1.219*** | [-1.469,-0.970] |
| Avg. Satisfaction with BB | | | 0.097 | [-0.006,0.201] | 0.097** | [0.035,0.160] | 0.097** | [0.035,0.160] |
| Talking*Mobile | | | | | | | 0.008 | [-0.008,0.025] |
| Constant | -0.772*** | [-1.116,-0.429] | -0.849*** | [-1.246,-0.452] | -0.849*** | [-1.106,-0.593] | -0.849*** | [-1.106,-0.592] |
| *N* | 147953 | | 145343 | | 145343 | | 145343 | |

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001. 95% CI = 95% confidence intervals (in brackets). Standard errors are clustered at the collection site level.




**Appendix Figure A4.1** Average marginal effect of talking about donations with 95% CI by level of altruistic values. AMEs are based on model 3 in Appendix Table A4.2.




**Appendix Figure A4.2** Average marginal effect of talking about donations with 95% CI by type of collection site. AMEs are based on model 4 in Appendix Table A4.2.

**Appendix Table A4.6** Robustness checks on the predictive power of talking about donations.

| | (1) | | (2) | |
|---|---|---|---|---|
| | Coef. | 95 % CI | Coef. | 95 % CI |
| *Individual level* | | | | |
| Word-of-mouth recruitment | 0.027 | [-0.005,0.058] | 0.169* | [0.026,0.313] |
| Talking about donations | 0.051** | [0.015,0.087] | 0.056 | [-0.102,0.214] |
| Experience | 0.007*** | [0.006,0.008] | | |
| Talking*Experience | -0.001 | [-0.002,0.000] | | |
| GST | -0.012 | [-0.034,0.011] | -0.019 | [-0.095,0.056] |
| Altruistic values | -0.028* | [-0.050,-0.006] | -0.158** | [-0.258,-0.058] |
| Working hours | -0.004*** | [-0.005,-0.002] | -0.006** | [-0.011,-0.002] |
| Age | 0.008*** | [0.006,0.009] | 0.009* | [0.002,0.017] |
| Male | 0.063*** | [0.027,0.100] | 0.005 | [-0.190,0.201] |
| Having children | -0.070** | [-0.115,-0.025] | 0.131 | [-0.055,0.318] |
| Rare blood type | 0.027 | [-0.016,0.070] | -0.014 | [-0.197,0.169] |
| Universal blood type | -0.018 | [-0.063,0.026] | -0.075 | [-0.307,0.158] |
| Awareness of need | -0.000 | [-0.029,0.028] | 0.087 | [-0.010,0.185] |
| Affective attitudes | 0.080*** | [0.058,0.103] | 0.223*** | [0.122,0.324] |
| Satisfaction with the BB | 0.048*** | [0.021,0.075] | 0.072 | [-0.057,0.202] |
| Wants more solicitations | 0.149*** | [0.092,0.206] | 0.127 | [-0.062,0.317] |
| Wants less solicitations | -0.320*** | [-0.409,-0.232] | -0.499 | [-1.090,0.092] |
| *Collection site level* | | | | |
| Prop. WOM recruitment | 0.398 | [-0.014,0.810] | 0.028 | [-0.317,0.374] |
| Avg. talking about donations | 0.108 | [-0.321,0.537] | 0.046 | [-0.369,0.461] |
| Mobile | -0.045 | [-0.152,0.062] | 0.089 | [-0.079,0.258] |
| Avg. age | 0.040*** | [0.024,0.056] | 0.005 | [-0.008,0.017] |
| Prop. male | 0.911*** | [0.512,1.310] | 0.181 | [-0.194,0.556] |
| Avg. Experience | -0.011** | [-0.018,-0.004] | | |
| Prop. want more solicitations | 0.087 | [-0.420,0.595] | -0.101 | [-0.425,0.222] |
| Prop. Want less solicitations | -3.212*** | [-4.521,-1.903] | -0.137 | [-2.155,1.880] |
| Avg. Satisfaction with BB | 0.195 | [-0.124,0.514] | 0.046 | [-0.267,0.358] |
| Constant | -3.003*** | [-4.469,-1.536] | -0.547 | [-2.057,0.964] |
| *N* | 52883 | | 3581 | |

Notes: The dependent variable in Model 1 is compliance with solicitations in 2013, and the sample is restricted to observations for donors that participated in the survey in 2012. In Model 2, the sample is restricted to donors that did not make any donations before participating in the survey. The robustness checks are described in more detail in section 5.2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 95% CI = 95% confidence intervals (in brackets).

**Appendix Table A4.7** Robustness checks: Alternative construction of main predictors.

| | (1) | | (2) | |
|---|---|---|---|---|
| | Coef. | 95 % CI | Coef. | 95 % CI |
| *Individual level* | | | | |
| Word-of-mouth recruitment | -0.022 | [-0.046,0.001] | -0.001 | [-0.022,0.020] |
| Talking about donations | 0.087*** | [0.063,0.112] | 0.094*** | [0.068,0.119] |
| Experience | 0.007*** | [0.006,0.007] | 0.007*** | [0.006,0.007] |
| Talking*Experience | -0.002*** | [-0.002,-0.001] | -0.002*** | [-0.002,-0.001] |
| GST | -0.012 | [-0.027,0.003] | -0.014 | [-0.029,0.001] |
| Altruistic values | -0.030*** | [-0.045,-0.015] | -0.029*** | [-0.044,-0.014] |
| Working hours | -0.004*** | [-0.005,-0.003] | -0.004*** | [-0.005,-0.003] |
| Age | 0.006*** | [0.005,0.007] | 0.006*** | [0.005,0.007] |
| Male | 0.056*** | [0.030,0.081] | 0.055*** | [0.029,0.080] |
| Having children | -0.092*** | [-0.122,-0.062] | -0.091*** | [-0.121,-0.060] |
| Rare blood type | 0.024 | [-0.004,0.052] | 0.026 | [-0.002,0.054] |
| Universal blood type | -0.009 | [-0.039,0.021] | -0.010 | [-0.040,0.021] |
| Awareness of need | 0.000 | [-0.021,0.022] | -0.000 | [-0.022,0.022] |
| Affective attitudes | 0.078*** | [0.061,0.095] | 0.077*** | [0.060,0.094] |
| Satisfaction with the BB | 0.083*** | [0.061,0.105] | 0.083*** | [0.061,0.106] |
| Wants more solicitations | 0.090*** | [0.050,0.130] | 0.092*** | [0.052,0.132] |
| Wants less solicitations | -0.423*** | [-0.490,-0.356] | -0.419*** | [-0.487,-0.352] |
| *Collection site level* | | | | |
| Prop. WOM recruitment | 0.185 | [-0.184,0.554] | 0.193 | [-0.167,0.553] |
| Avg. talking about donations | 0.284 | [-0.084,0.653] | 0.275 | [-0.093,0.643] |
| Mobile | -0.008 | [-0.099,0.083] | -0.003 | [-0.095,0.089] |
| Avg. age | 0.031*** | [0.018,0.043] | 0.031*** | [0.019,0.044] |
| Prop. male | 0.808*** | [0.482,1.134] | 0.827*** | [0.499,1.155] |
| Avg. Experience | -0.010*** | [-0.016,-0.005] | -0.010*** | [-0.016,-0.005] |
| Prop. want more solicitations | -0.163 | [-0.576,0.249] | -0.146 | [-0.562,0.270] |
| Prop. Want less solicitations | -2.825*** | [-4.141,-1.509] | -2.731*** | [-4.067,-1.394] |
| Avg. Satisfaction with BB | 0.254 | [-0.021,0.529] | 0.253 | [-0.023,0.529] |
| Constant | -2.969*** | [-4.243,-1.694] | -3.027*** | [-4.314,-1.740] |
| *N* | 145343 | | 144573 | |

Notes: Model 1 uses an alternative construction of the Word-of-mouth recruitment variable indicating whether donors where only recruited via word-of-mouth, as described in section 3.2. Model 2 excludes donors that often talk about donations, as described in section 5.2. * p < 0.05, ** p < 0.01, *** p < 0.001. 95% CI = 95% confidence intervals (in brackets).

# Chapter 5

# How group membership affects prosocial behaviour: Evidence from a nationwide group donation programme among blood donors in Australia

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## Abstract

Many public goods rely on individuals' cooperation and prosocial behaviour, but sustaining high levels of contributions is often difficult. Laboratory experiments suggest that contributions to club goods (shared only within a group) can be increased by group formation among contributors. We study whether the effectiveness of group formation generalises to high-cost contributions to a real-world public good (shared beyond group boundaries). To do so, we analyse a nationwide group donation programme implemented among blood donors in Australia, which enables donors to form groups with other donors. Using a difference-in-differences design, we show that joining a blood donor group increases yearly donation frequency by approximately 37%, and that the positive effect remains for approximately two years. Furthermore, our results show that joining a more active group increases donation frequency more strongly than joining a less active group. Our study contributes to the literature by demonstrating that the strategy of group formation among contributors works in the field, at societal scale, and for the high-cost prosocial behaviour of blood donations. In addition, it informs the practice of blood banks and other organisations dependent on people's prosocial behaviour.

## 5.1 Introduction

One of the major challenges in research on prosocial behaviour is to identify strategies that enable its sustained provision (Chaudhuri 2011; Rand and Nowak 2013; Simpson and Willer 2015). Results from laboratory experiments suggest that social mechanisms such as reciprocity (Axelrod 1984; Bolton et al. 2004; Gächter et al. 2017; Nowak and Sigmund 2005; Rand and Nowak 2013; Simpson et al. 2018), altruistically motivated sanctions or rewards (Andreoni et al. 2003; Fehr and Gächter 2000; Fehr and Gächter 2002; Fehr and Schurtenberger 2018), and leveraging group formation (Brekke et al. 2011; Gächter and Thöni 2005; Guido et al. 2019; Gunnthorsdottir et al. 2007; Page et al. 2005) hold promise. However, implementing such strategies to maintain prosocial behaviour outside the laboratory and at societal scale is a difficult task: some mechanisms (e.g., sanctions or rewards) may not work for ethical and practical reasons, and it is unclear to what extent the results of laboratory experiments translate to field applications (Baldassarri and Grossman 2013; Galizzi and Navarro-Martinez 2018; Stutzer et al. 2011). A promising but underexplored mechanism to sustain prosocial behaviour that benefits society at large is the formation of identity-based groups among contributors (Charness and Chen 2020).

A key target domain for such behavioural interventions is the donation of whole blood, plasma, and platelets, collectively referred to as blood donations (Chell et al. 2018; Ferguson et al. 2023; Godin et al. 2012; Southcott et al. 2022; Stutzer et al. 2011; Sun et al. 2019). Blood products are indispensable in numerous medical procedures (e.g., transfusions, treatment of trauma or burn) and the production of life-saving drugs. To meet their demand for blood, many countries rely on voluntary and non-remunerated blood donors (Ferguson 2022; Healy 2000; Slonim et al. 2014). These donors are strongly driven by non-pecuniary motivations. At the same time, blood donation is individually costly in terms of time and potential discomfort (e.g., pain, nausea, dizziness, and fainting). This makes blood donation a textbook example of prosocial behaviour, benefiting society at large at one's own cost (Ferguson 2022; Wittek and Bekkers 2015). Yet, despite many donors' efforts, most countries struggle to meet the demand for blood through domestic collection (Jaworski 2020; Slonim et al. 2014).

In this paper, we examine to what extent group formation can be used to promote blood donation by analysing a nationwide group membership programme implemented in Australia. Nationally responsible for the collection of blood via voluntary and non-remunerated donations is the Australian Red Cross Lifeblood (Lifeblood). Since 2015, the 'Lifeblood Teams' group donation programme has enabled donors all over the country to form groups and to formally register as a 'Lifeblood Team'. These groups are often formed at the workplace, educational institution, or among neighbours, family, or friends, thus tapping into pre-existing social ties and creating scope for group identity to boost blood donations. The

size of these groups ranges from a few donors to thousands. Donors may be directly invited to join a team by existing group members, or join a team via the website, mobile app or in a donor centre (without being invited, and without notification to group members). All donations made by group members are then counted toward a team tally publicly available on Lifeblood's website. In 2022, approximately 36% of all blood donations in Australia were linked to a Lifeblood Team (Lifeblood 2022).

Our analysis focuses on the period from 2016 to 2019, where a nationally consistent implementation of the programme was in place, and before the COVID-19 pandemic disrupted the blood collection process from 2020 onwards. Drawing on data covering the entire population of blood and plasma donors in Australia who joined a group in this period, we apply a quasi-experimental differences-in-differences (DiD) design that uses the variation in when donors join a group to identify the effect of joining a group on donation behaviour. Incorporating recent advances in the methodological literature on DiD, we employ multiple estimation strategies that account for potential treatment effect heterogeneity across time and across cohorts, and potential violations of the parallel trends assumption (Arkhangelsky et al. 2021; Callaway and Sant'Anna 2021; Wooldridge 2023). To quantify blood donation behaviour, we focus on the key metric of donation frequency. This is an interesting outcome from both a theoretical and a practical point of view. Naturally, more frequent donations require more effort from donors, and it is therefore a good measure of the extent of prosocial behaviour. In addition, the frequency of donations is an important metric for blood banks, since it is generally more efficient to rely on a smaller number of repeat donors rather than a larger number of one-time donors due to more burdensome screenings for first-time donors (Dongen 2015; Masser et al. 2008). Compared to the outcomes studied in previous experimental and field studies, blood donations are high cost, and there are no tangible individual benefits of donating. Therefore, conducting a preregistered analysis of this group donation programme using high-quality register data provides a strong test of how group membership affects repeated high-cost prosocial behaviour in the real world.

Our main finding is that joining a blood donor group strongly increases donation frequency. Based on our preferred specification, joining a group increases donation frequency by about 37% in the three years after joining a team. In addition, we show that joining a more active group more strongly increases donation frequency than joining a less active group, by about 2.5% more per standard deviation increase in the average donations of other group members. This latter finding is in line with the argument from previous experimental studies that the effectiveness of group membership is derived in part from exposure to other prosocial individuals (Gunnthorsdottir et al. 2007). At the same time, this difference in the effectiveness of joining a more and less active team is relatively small, indicating that there are additional mechanisms at play.

Another important finding is that the effect of joining a group is highly variable with the duration of group membership: joining a group increases donation frequency by about

90% in the year that a donor joins a group, by about 14% in the year after joining a group, and decreases donation frequency by about 30% two years after a donor initially joins a group. In analyses disaggregated to the monthly level, we show that there is a very strong increase in donation frequency in the first months after joining a team, which is because many donors that join a group simultaneously sign up for their first group donation. In the following months up to the 15$^{th}$ month after joining a team, there is a more modest increase in donation frequency of approximately 25%, and a levelling off to about equal donation frequency to the comparison group from the 17$^{th}$ month onwards. As a potential explanation for the decreasing effectiveness of group membership over time, we explored donation frequency induced low haemoglobin deferral. Indeed, we find that donors who join a group are more likely to be deferred in the years after joining a group. An analysis of heterogeneous effects by age, gender, and whole blood or plasma donor status further supports this explanation: joining a team is more effective for male donors, older donors, and plasma donors, and this difference increases over time. Donors with these characteristics are generally less susceptible to iron deficiency and consequent low haemoglobin deferral following an increase in donation frequency.

This study contributes to the field of institutional design for motivating prosocial behaviour (Chell et al. 2018; Dannenberg and Gallier 2020; Godin et al. 2012; Gorleer et al. 2023; Healy 2000; Southcott et al. 2022; Stutzer et al. 2011; Sun et al. 2019). Expanding on these previous studies, which have shown that group formation positively impacts prosocial behaviour in settings with strategic interests for the individual to contribute, this paper demonstrates that the formation of identity-based groups increases prosocial behaviour that benefits society at large (as opposed to only the ingroup), and without a tangible individual benefit from giving. Our results therefore demonstrate that the strategy of group formation among contributors works in the field, at societal scale, and even for the high-cost prosocial behaviour of blood donations. In addition, the evidence provided in this paper can be instrumental in informing the practice of blood banks and other organisations that depend on the repeated contributions of individuals, such as organisations in the field of charitable giving or volunteering. Our results show that the strategy is effective, but also demonstrate the importance of monitoring the sustainability of public goods supply in the long run[1]. These are important insights for both organisations that have already implemented programmes that make use of group formation (e.g, Lifeblood and Kiva.org) and organisations aiming to implement similar strategies in the future.

The remainder of the paper is organised as follows: section 5.2 provides background on previous literature and derives the hypotheses to be tested; section 5.3 describes the data sources and provides descriptive statistics; section 5.4 discusses the empirical strategy; section 5.5 presents the results; section 5.6 discusses the results and potential implications

[1]This is particularly true for the case of blood donations, where an 'oversupply' of the public good may have negative consequences for individual health.

and concludes.

## 5.2 Background

The topic of group membership and prosocial behaviour has been extensively studied across the social sciences. For example, the social identity perspective in social psychology (Hornsey 2008; Spears 2021; Tajfel and Turner 1979; Turner et al. 1987), symbolic interactionism in sociology (Blumer and Blumer 1969; Hogg and Ridgeway 2003; Mead 1934), and more recently 'identity economics' (Akerlof and Kranton 2000; Charness and Chen 2020) have all contributed to a better understanding of how processes of social identity formation and self-categorisation in groups shape prosocial behaviour. Group membership provides emotional commitment, shared identity, enjoyment of shared experiences, interest in the other members' welfare, feelings of moral obligation, intergroup competition, and reduced uncertainty about others' likely behaviour, all of which can promote prosociality (Charness and Chen 2020; Kollock 1998; Simpson and Willer 2015; Sun et al. 2019). The bulk of this literature has focused on how group membership affects giving towards in-group versus out-group members. An established empirical finding is that group formation results in in-group favouritism (Balliet et al. 2014; Goette, Huffman, and Meier 2012; Goette, Huffman, Meier, and Sutter 2012). That is, people are typically more cooperative towards members of the in-group as compared to members of the out-group.

Another strand of largely experimental literature has shown that group formation among contributors can slow or even halt the decline of cooperation that is typically observed in public goods games (PGGs) (Gächter and Thöni 2005; Guido et al. 2019; Gunnthorsdottir et al. 2007; Page et al. 2005). In comparison to randomly composed groups, contributions in groups of people that have previously shown their willingness to contribute (e.g., via contributions in previous rounds of the game) are always higher and decay slower over time. The strategy of group formation with assortative matching uses the insight that a substantial proportion of people are conditional cooperators: they tend to contribute if others do so as well, but decrease their contributions if they believe that others will not contribute (Fischbacher et al. 2001; Ones and Putterman 2007; Thöni and Volk 2018).

Can group formation among contributors promote contributions to a large-scale public good such as blood donation? Voluntary and non-remunerated blood donation systems share many conceptual similarities to public goods experiments: there are no high-value incentives that compensate donors with the full social value of their contribution (Goette and Tripodi 2024; Graf et al. 2023), they are anonymous and non-targeted such that donors cannot benefit their own kith or kin (Ferguson 2022; Ferguson and Lawrence 2016), and there is an opportunity to free ride that is also widely used (Abásolo and Tsuchiya 2014). However, a crucial difference is the scale of the public good. In PGG experiments, groups

are usually small, typically consisting of four players. In addition, the contributions in experiments on group formation typically go to a club good whose benefits are shared only among members of the group (Gross et al. 2023). Blood donations, in contrast, are contributions to a public good that is shared among all members of society. Taken together, these factors lead to a much lower marginal per capita return (MPCR) from contributing (Isaac and Walker 1988), which crucially affects the extent of cooperation in PGGs (Zelmer 2003). While Gunnthorsdottir et al. (2007) have demonstrated the effectiveness of group formation even with a relatively low MPCR, the application of the mechanism to the provision of a public good as opposed to a club good poses an additional challenge due to the diminished role of strategic interests.

Membership in a group opens up multiple avenues beyond strategic interests to increase motivation to donate blood. Mechanisms such as shared identity, intergroup competition, a reminder function, and reduced uncertainty about others' behaviour likely contribute to its effectiveness. First, emphasising common identity may increase cooperation within groups and increase competition between groups (Penner. et al. 2005). Social identities emerge as oneself or others identify an individual with a specific identity, and they are made salient when social relations are tied to this identity (Charng et al. 1988; Stryker and Burke 2000; Turner 1978). The Lifeblood Teams programme provides an easy opportunity for self-categorisation into a blood donor group, and to develop or strengthen a social identity as a blood donor and member of a specific blood donor group. Holding a blood donor identity has been identified as one of the strongest reasons for repeatedly giving blood (Edwards et al. 2023; Masser et al. 2008). Competition between groups, another important aspect of the Lifeblood Teams programme[2], has been shown to increase contributions in laboratory experiments representing social dilemmas (Erev et al. 1993; Gunnthorsdottir and Rapoport 2006; Rapoport and Bornstein 1987). It is particularly effective in a group setting, because people do not want to let down other group members (Charness and Holder 2019). Finally, membership in groups of contributors might be effective for increasing contributions in PGGs because it reduces uncertainty about the behaviour of others (Gunnthorsdottir et al. 2007). Since donors in a blood donor group know that other members of their group are committed to give blood, it likely reduces their perception that they might be taken advantage of by free-riders.

To what extent can we expect findings from laboratory experiments to translate to field applications? Galizzi and Navarro-Martinez (2018) have shown that individual decisions in social preferences experiments, such as the PGG, are at best weakly correlated with participants real-world prosocial behaviour. More generally, even subtle differences in the context have been found to strongly affect to what extent people behave prosocially (Galizzi and Navarro-Martinez 2018; Goeschl et al. 2020; Levitt and List 2007).

[2]See Bryant et al. (2023) for a case-study of the effect of intergroup competition within the Lifeblood Teams programme on recruitment and donation rates.

The strategy of group formation to increase prosocial behaviour has rarely been tested in the field. A study on giving circles for charitable giving — groups in which donors pool their resources and jointly decide on their distribution — found that many people perceive their donations to increase after joining a giving circle (Eikenberry et al. 2009). Members felt that joining a giving circle increases their awareness of need, that it made giving a more central part of their life, and that group membership served as a reminder to give. However, conditional on income, Eikenberry et al. (2009) did not find a significant difference in the amount donated between members and non-members. A successful real-world implementation of the strategy comes from the area of prosocial lending on the microlending platform Kiva.org. In observational data and a field experiment, two studies found that lenders who joined a group of other contributors subsequently increased their lending frequency and amount (Ai et al. 2016; Chen et al. 2017). However, coordination and information sharing about lenders likely played an important role in this context. Compared to giving circles and prosocial lending, the Lifeblood Teams programme operates at a much larger scale, involves a prosocial behaviour that is higher cost, and benefits unknown and unrelated others (as is not necessarily the case with prosocial lending or charitable giving). Our empirical setting can therefore provide a strong test of the effectiveness of group membership in a setting without direct group benefits. Based on the present evidence from the lab and the field, we hypothesise that:

Hypothesis 1: Joining a blood donor group increases donation frequency.

A factor that is likely crucial for the effectiveness of group membership is the composition of the groups in terms of the donation activity of other members. In PGG experiments that make use of group formation, contributions are higher over time because cooperators do not decrease their contributions over time when they are surrounded by other cooperators, as opposed to when they are surrounded by a random group including non-contributors (Gunnthorsdottir et al. 2007). In addition, knowing that there are no free-riders in the group seems to further increase the contributions in groups of cooperators (de Oliveira et al. 2015). In the field, however, blood donors might end up in groups where other donors are not very active contributors. If this is the case, the effectiveness of group membership will likely be reduced as well (de Matos Fernandes et al. 2022; de Oliveira et al. 2015). The main hypothesised mechanism through which group formation increases contributions is that membership in groups of other contributors reduces the perceptions of being taken advantage of by free riders (Gunnthorsdottir et al. 2007).

This explanation is in line with a larger body of literature on the norm-based explanation of conditional cooperation. For many domains of prosocial behaviour, it has been shown that individuals tend to contribute more when such behaviour is perceived to be the social norm (Cialdini et al. 1990; Frey and Meier 2004; Schultz et al. 2007; Shang and Cro-

son 2009). Otten et al. (2022) have further shown that this mechanisms is at work when people join a group and adjust their contributions to match those of the incumbent group members. The direct association between own and others' behaviour has also been found for blood donation behaviour, where a donor's contributions are affected by the contributions made by other donors within the donor's social network (Bruhin, Goette, Haenni, and Jiang 2020; Schröder et al. 2023).

Based on the above mechanisms, joining a group of more active donors should be more effective in increasing donations. Using the average donation frequency of other donors in the group as a measure for the activity of blood donor groups, we hypothesise that:

Hypothesis 2: Joining a group where other donors have a higher donation frequency more strongly increases donation frequency than joining a group that has a lower donation frequency.

We preregistered our hypotheses, operationalisation of variables, and analysis plan at the Open Science Framework (OSF): https://osf.io/eydtp.

## 5.3 Data sources

Our analysis draws on routinely collected register data provided by the Australian Red Cross Lifeblood (Lifeblood). Lifeblood is the only organisation responsible for collecting blood donations in Australia. Our study therefore samples from the entire population of blood donors in Australia.

### 5.3.1 Study period and sample

A nationally consistent implementation of the group-donation programme was established in 2015. We therefore take 2016 as the start of our study period, and those who joined a group in 2016 as the first cohort. We set 2019 as the end of our study period, since from 2020 onwards, the COVID-19 pandemic disrupted the blood collection process in general and the role of the group-donation programme in particular. To be able to assess donation behaviour before joining a group, we obtain donation data going back to 2014 and limit our sample to donors who have been donating since before 2014. This allows us to assess trends in donation behaviour before joining a group for each of the cohorts.

Our final data set contains information on 72212 donors who meet these criteria. In contains information on each donation appointment in the period from 2014-2019, the type of donation (whole blood, plasma, or platelet), the start dates of group membership, donation history, and the number of appointments and donations before the start of the study period. Two additional data sets contained information on sociodemographic background

variables (the donor's age, sex, and state/territory), and deferral. Access to the data was only granted after preregistration of the study, as assured by the Lifeblood data manager (see the letter from the data manager: https://osf.io/5jbx8). The data sets were merged and aggregated to the donor-year level. The data will be made available after completion of the project on the OSF project page at https://osf.io/5jbx8/.

### 5.3.2 Pilot data extraction

In the design phase of our study, we performed a pilot data extraction from the Lifeblood donor database. This was to minimise the risk of unexpected difficulties during the final data analysis, and to learn about potentially necessary exclusion criteria (e.g., recording errors, nonsensical values, outliers) for the preregistered main data analysis (Nosek et al. 2018). Two samples were extracted from the Lifeblood donor database: pilot data set one (PD1) was a random sample of 858 individual donors, and pilot data set two (PD2) was a sample of 14 complete groups and their members[3].

The pilot data analysis showed that in rare cases (1.4% of donors in PD1), group membership was recorded as 'unknown'. For these donors, we know *when* they joined a group, but we do not know *which* group they joined. Therefore, we exclude these donors for the analysis of Hypothesis 2. The pilot data also showed that more than 75% of donors make up to four donations per year. This is well below the maximum potential donation frequency in Australia, where plasma can be donated every two weeks, and whole blood can be donated every 12 weeks. This means that a ceiling effect is unlikely to limit the potential effectiveness of group membership on donation frequency.

Importantly, the sample sizes and sample characteristics for these pilot data sets were intentionally chosen not to provide meaningful information about the hypothesised relationships. Taken together, PD1 and PD2 provide a sample of only 692 donors that might provide information about Hypothesis 1, which is too few given our power analysis. Further details on the pilot data analysis can be found in the preregistration.

### 5.3.3 Sample size justification

Based on publicly available information (Lifeblood annual reports) and information from the pilot data sets, we conservatively estimated that our final sample should consist of at least 36000 donors who joined a group between 2016 and 2019. Taking this sample size as given, we conducted a Monte Carlo simulation to estimate the minimum detectable effect size (MDE) of our study given a power level of $1 - \beta = 95\%$, where $\beta$ is the probability of making a type II error. The power analysis, reported in detail in the preregistration, showed that for our desired power level of 95%, our MDE for Hypothesis 1 would be a

[3]The sampling strategy, the pilot data, and the pilot data analysis are described in more detail in the preregistration.

2% increase in the yearly donation frequency. For hypothesis 2, the MDE would be a 5% difference in donation frequency between those that join a more versus a less active group. Both of these MDEs are substantially smaller than the effects observed in previous studies (e.g., Ai et al. 2016; Chen et al. 2017; Gächter and Thöni 2005; Gunnthorsdottir et al. 2007)[4], and smaller than what was considered practically meaningful by the study authors and Lifeblood staff in terms of the cost-effectiveness of the group membership programme.

The actual sample obtained from the Lifeblood donor database was a sample of 72212 donors that joined a group between 2016 and 2019, and that have been donating since before 2014. For these donors, we observe about three million donation appointments during the study period from 2014 to 2019. This means that our study is well-powered to detect any theoretically and practically meaningful effects.

The pilot data sets and code for the pilot data analysis and power analysis are available on the OSF project page at https://osf.io/5jbx8/.

## 5.4 Empirical strategy

### 5.4.1 Construction of the primary outcome variable

Our main outcome of interest is the individual's donation frequency. It is given by the number of whole blood, plasma, and platelet donation attempts per year. We use the number of donation attempts instead of only successful donations because it better reflects the individuals prosocial behaviour (going to the blood bank with the intention to make a donation, irrespective of potential non-anticipated deferral for medical reasons). Appendix Figure A5.1 shows a histogram of the yearly donation attempts.

### 5.4.2 Construction of the 'treatment' indicator

The indicator for group membership indicates whether the donor joined a group in a given year. It takes the value 1 in the year that a donor first joins a group and keeps the value 1 in all following periods. As described above, we study donors that joined a team between 2016 and 2019, and therefore end up with four relatively equal-sized yearly cohorts of approximately 18000 donors each (see Appendix Figure A5.2).

### 5.4.3 Construction of the group activity indicator

To measure the donation activity of groups, we calculate the average donation frequency of all group members in the year prior to the year that the individual joined the group. We use this lagged group activity indicator to ensure that it is not affected by the donors

[4] More detail on effect size estimates in previous studies is provided in the preregistration.

joining that group. Appendix Figure A5.3 shows the distribution of the average donation frequency within groups for the four cohorts. There is a relatively large variation in the average number of donations per group, but the distribution is similar across cohorts.

Appendix Table A5.1 lists all the remaining variables used in our analysis and describes their construction in detail. Table 5.1 presents summary statistics of the study variables.

**Table 5.1** Summary statistics of donor characteristics

| Variable | N | Mean | SD | Median | Min | Max |
|---|---|---|---|---|---|---|
| Yearly donations | 72212 | 2.00 | 2.78 | 1.17 | 0.17 | 28.17 |
| Male | 72212 | 0.46 | 0.50 | 0.00 | 0.00 | 1.00 |
| First donation year | 72212 | 2006.87 | 4.00 | 2007 | 1977 | 2013 |
| Start of group membership | 72212 | 2017.47 | 1.10 | 2017 | 2016 | 2019 |
| Group activity | 54086 | 3.26 | 1.63 | 2.99 | 1.00 | 26.00 |
| Age | 72212 | 36.52 | 12.55 | 35.00 | 16.00 | 75.00 |
| Experience | 72212 | 10.58 | 4.16 | 11.00 | 2.00 | 40.00 |
| Habit | 72212 | 3.32 | 6.04 | 1.00 | 0.00 | 56.00 |
| WB-donor status | 72206 | 0.75 | 0.31 | 0.94 | 0.00 | 1.00 |
| Deferral | 72212 | 0.28 | 0.45 | 0.00 | 0.00 | 1.00 |

Notes: Experience is the years since registration. Habit is the number of donations in the two years prior to joining a team. WB-donor status is the proportion of whole blood donations out of the total donations prior to joining a group. Deferral is a dummy variable indicating whether a donor has been deferred in the two years prior to joining a group. Appendix Table A5.1 describes the construction of variables in detail.

### 5.4.4 Identification strategy

The main aims of this paper are to estimate the effect of joining a blood donor group on donation frequency (hypothesis 1), and the difference in the strength of the effect between joining a more active versus a less active group (hypothesis 2). We use a quasi-experimental difference-in-differences (DiD) design to test these hypotheses.

Generally speaking, the DiD approach compares differences in how the outcome develops over time between treated groups and control groups. In our setting, joining a group represents the 'treatment', and donors that did not yet join a group are used as the 'control groups'. The crucial assumption for the DiD design to successfully recover the causal effect of joining a group on donation frequency is the parallel trends assumption: over time, the donation frequency among those that joined a group and those that did not would have followed the same trends if the former group would not have joined a group. In the general donor population, this assumption is unlikely to hold because donors that join a group and donors that never join a group likely differ in their characteristics and motivations such that trends in their donation frequency cannot be assumed to follow parallel trends. However, the assumption of parallel trends is much more likely to hold among donors that all

join a group, with the only difference being the time that they join a group. Therefore, we construct a sample of donors that all join a group at some point between 2016 and 2019, and that have been donating since at least 2014. We examine 4 cohorts, namely those that joined a group in 2016, 2017, 2018, and 2019.

Trends in donation frequency might further depend on observable characteristics of individuals, such as their prior experience as a donor or socio-demographic variables. We condition on a range of (potential) confounders that have been found to affect blood donation behaviour in previous studies (for a review and meta-analysis see Bednall et al. 2013), and that are potentially associated with the decision about joining a group, namely the donor's age, sex, habit, experience, deferral, state of residence, and being a whole blood donor (the measures are described in more detail in Appendix Table A5.1). All covariates are measured in the year before a donor joins a group to ensure that none of the covariates are affected by the donors decision to join a group itself. Conditioning on these covariates allows the selection into groups to be based on these initial differences. The conditional parallel trends assumption underlying our analysis is therefore that, conditional on the covariates, the difference in donation frequencies between group-donors and not-yet-group-donors would have stayed the same in the after period as it was in the before period if group-donors would not have joined a group. The causal effect of joining a group on donation behaviour is therefore identified by the difference in the timing of joining a group.

The assumption of conditional parallel trends builds on unobservable counterfactuals about how donations of those that did join a group would have developed if they would not have joined a group. Therefore, it cannot be tested directly. However, the availability of multiple pre-treatment time periods allows us to test to what extent the assumption of parallel trends holds in periods before treated units actually become treated (i.e., to conduct a pre-test) (Roth 2022; Wooldridge 2023). The intuition underlying the pre-test is that if trends in donation frequency are parallel in the periods before donors actually join a group, it is more plausible that they would also be parallel in the later periods.

Further necessary for the DiD design to recover the causal effect of joining a group on donation behaviour are the assumptions of irreversibility of treatment and limited treatment anticipation (Callaway and Sant'Anna 2021; Wooldridge 2023). Irreversibility of treatment means that once a donor joins a group, they remain in a group for the following periods, or that donors at least do not 'forget' about the experience of joining a group. In practice, donors do not need to 'cancel' their group membership when they no longer wish to be active, and the data shows that they rarely do. For the interpretation of results, this means that we identify the effect of joining a group on donation behaviour as opposed to the effect of currently being in a group. The assumption of limited treatment anticipation requires that donors either do not change their behaviour in anticipation of joining a group, or that we can detect the 'anticipation horizon', that is, the time period in which individuals

already act upon the anticipation of joining a group.

In the following, we describe the estimation procedure and the approach to assessing the identifying assumptions.

### 5.4.5 Estimation

Our dependent variable is the number of donations in a given year. Since this is a count variable, we use the Poisson DiD approach recently developed in Wooldridge (2021) and Wooldridge (2023). This estimation method overcomes shortcomings of the traditional two-way fixed effects (TWFE) DiD estimator in settings with multiple time-periods, variation in treatment timing, and potential treatment effect heterogeneity, which have been extensively discussed in recent DiD literature (Baker et al. 2022; Borusyak et al. 2022; Goodman-Bacon 2021). Intuitively, the method extends the traditional DiD approach by saturating the model with interaction effects that account for potential treatment effect heterogeneity over time and across cohorts. In comparison to other recently developed approaches (Borusyak et al. 2022; Callaway and Sant'Anna 2021; de Chaisemartin and D'Haultfuille 2020; Sun and Abraham 2021), this method extends to some non-linear models, and allows for the analysis of treatment effect heterogeneity. The model is given by:

$$\begin{aligned} E(Y_{it}|D_{iq},\ldots,D_{iT},\mathbf{X}_i,\mathbf{W}_i) = \exp(&\alpha + \sum_{g=q}^{T-1}\beta_g D_{ig} + \mathbf{X}_i\boldsymbol{\kappa} + \sum_{g=q}^{T-1}(D_{ig}\cdot\mathbf{X}_i)\boldsymbol{\eta}_g \\ &+ \sum_{s=2}^{T}\gamma_s fs_t + \sum_{s=2}^{T}(fs_t\cdot\mathbf{X}_i)\boldsymbol{\pi}_s \\ &+ \sum_{g=q}^{T-1}\sum_{s=g}^{T-1}\delta_{gs}W_{itgs} \\ &+ \sum_{g=q}^{T-1}\sum_{s=g}^{T-1}(W_{itgs}\cdot\dot{\mathbf{X}}_{ig})\boldsymbol{\zeta}_{gs}), \end{aligned} \tag{5.1}$$

where the four cohorts are indicated by year that they joined a group denoted as $g$ with $g \in \{2016, 2017, 2018, 2019\}$, $q$ indicates 2016 as the year where the first donors in our sample joined a group, $s = g,\ldots,T$ indicates time periods where cohort $g$ joined a group, $D_{ig}$ is a binary indicator for whether a donor already joined a group or not, $X$ is a $1\times K$ vector of time-constant covariates with coefficients $\boldsymbol{\kappa}$, $fs_t$ are time dummies with $fs_t = 1$ if $s = t$, and $fs_t = 0$ if $s \neq t$. The time-varying indicators for joining a group are defined as

$$W_{itgs} = D_{ig}\cdot fs_t, g = q,\ldots,T; s = g,\ldots,T, \tag{5.2}$$

and $\dot{X}_{ig}$ are the covariates demeaned by cohort given by

$$\dot{X}_{ig} = X_i - \bar{X}_g. \tag{5.3}$$

The coefficients in $\delta_{gs}$ are the (approximate) percentage difference in the number of donations between those that joined a group in a given year and those that did not yet join a group. The average partial effects (APE) for these coefficients provide the group-time average treatment effects ATT($g$,$t$). The test for hypothesis 1 is the overall ATT, which is the weighted average of the group-time average treatment effects.

The coefficients in $\zeta_{gs}$ provide estimates for how the effect of joining a group varies with the covariates. The test for hypothesis 2 is the coefficient on the interaction terms between joining a group and the donation activity in the group.

To conduct the pre-test, we estimate an event-study specification where the dummies $D_{ig} \cdot fs_t$ are included in equation 5.1 for $g = q,\ q+1,\ \ldots,\ T$, and for $s = 2,\ \ldots,\ g-1$, that is, for the periods before the cohorts actually join a group. The coefficients for these interaction terms indicate the pre-treatment estimates, which can be used to test the assumptions of parallel trends and treatment anticipation. We estimate three specifications: one without covariates (model 1), one with the time-constant covariates age, gender, and state (model 2), and one specification that additionally includes donor experience, habit, and previous deferral (model 3)[5]. To account for a potential violation of the assumption of parallel trends, we estimate a specification that additionally allows for cohort-specific linear time trends by additionally including the interactions $D_{iq} \cdot t,\ D_i, q+1 \cdot t, \ldots, D_{iT} \cdot t$ (model 4). This specification explicitly allows for non-parallel linear trends per cohort, which reduce bias in estimates of the ATT estimates due to potential violations of the parallel trends assumption (Bilinski and Hatfield 2020; Wooldridge 2023). The pre-treatment estimates also allow us to assess the existence of treatment anticipation. If donors already increase their donation frequency before joining a group, the pre-treatment estimates in the period before joining a group will be positive and the estimates of joining a group will be downward biased. As an additional test for the assumption of no treatment anticipation, we re-estimate model 1 using $W_{i,t+1}$ as a treatment indicator (an indicator of joining a group next year) instead of $W_{it}$.

The models are estimated via pooled Poisson quasi-maximum likelihood estimation (QMLE). Standard errors are clustered on the individual level to account for serial correlation. All pre-processing of data and statistical analyses were conducted in R version 4.3.0 (R Core Team 2021)[6].

[5] It is an open debate whether DiD designs should condition on pre-treatment outcomes (such as the current habit for donating blood) (Bach et al. 2023; Roth et al. 2023). Therefore, we present the results of both specifications

[6] Details on the packages used can be found in the R markdown script, which is available at the OSF project page at https://osf.io/5jbx8/.

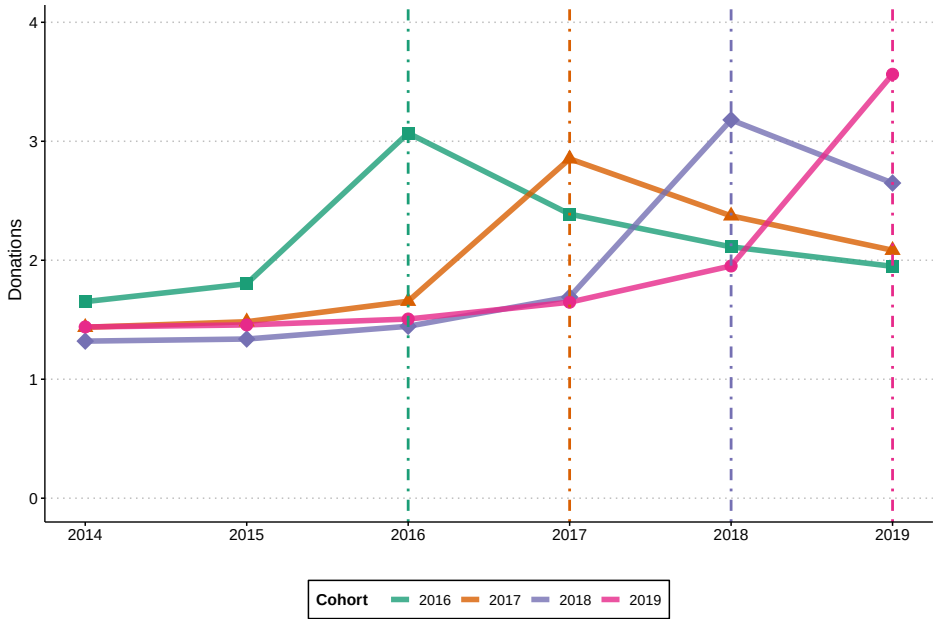


**Figure 5.1** Donation frequency by cohort over time.

## 5.5 Results

Figure 5.1 shows how the donation frequency of each cohort develops over time. We can see that for each of the cohorts, donation frequency strongly increases when joining a group, from about 1.6-1.9 donations in the year before joining a group to about 3 donations in the year that each cohort joined a group. In the following years, donation frequency slowly levels off. The 2016 cohort, which we observe for the longest period after joining a group, almost reaches their initial level of donation frequency before they joined a group.

Figure 5.2 shows the results from the event-study regression comparing those that joined a group to those that did not yet join a group. It shows to what extent joining a group affects donation frequency in the year that a donor joined a group (year zero) and the two years after joining a group. In addition, it shows to what extent trends in donation frequencies between cohorts already differed before joining a group (years -3 to -1). As can be seen from these pre-treatment estimates, there is evidence that the parallel trends assumption is not met in the years before donors join a group, and particularly in the year just before a donor joins a group. A robust Wald test of the pre-treatment coefficient confirms that the parallel trends assumption should be rejected for models 1-3 (see Table 5.2).

To correct for the violation of the parallel trends assumption, Model 4 additionally accounts for cohort-specific linear trends in donation frequencies. In Model 4, joining a group

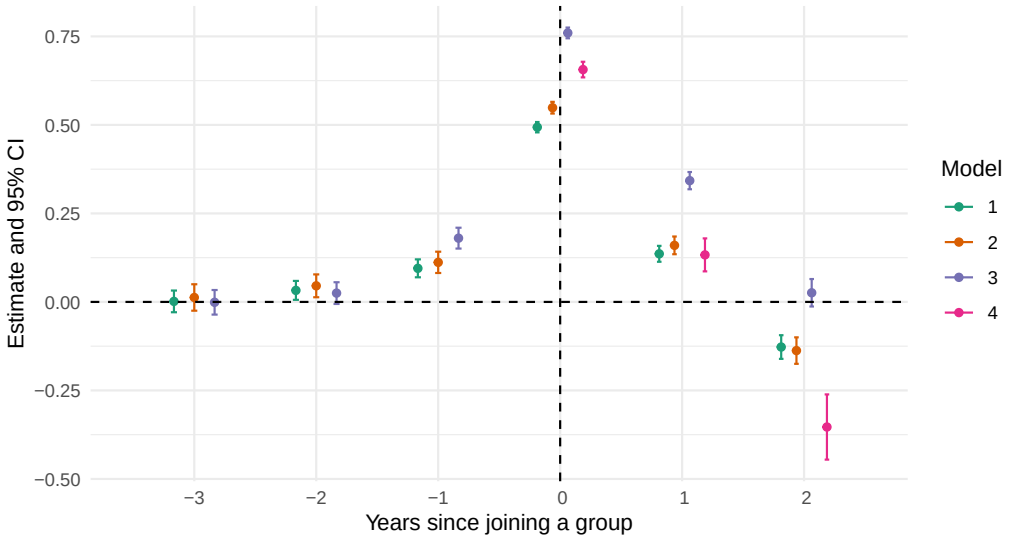


**Figure 5.2** Event-study estimates of the effect of joining a group on donation frequency.

Notes: This figure presents the estimates from the event-study regression. Parameters for post-treatment periods are derived from specifications that do not include the pre-treatment estimates to avoid the problem of biased treatment effect estimates after pre-testing (Borusyak et al. 2022; Roth 2022; Sun and Abraham 2021). Model 1 is estimated without covariates. Model 2 includes age, gender, and state fixed effects as pre-treatment covariates. Model 3 includes experience, habit, deferral, and whole blood donor status as additional covariates to those included in model 2. Model 4 adds cohort-specific linear trends to model 3, which serves as a correction for a violation of the parallel trends assumption (Bilinski and Hatfield 2020; Wooldridge 2023). Due to the inclusion of cohort-specific linear trends, pre-treatment estimates are not available in Model 4.

is estimated to increase donation frequency by about 37% ($e^{0.313} = 1.368$, see Table 5.2). From Figure 5.2, we can further see that the strength of the effect of joining a group on donation frequency changes with the duration since joining a group. Initially, donation frequency strongly increases by about 90% in the year of joining a group. One year later, it is still estimated to be about 14% higher than donation frequency among those that did not yet join a group. Two years after first joining a group, however, donation frequency is even estimated to be about 30% lower than in the comparison group.

The pattern of pre-treatment estimates more specifically suggests that the violation of the parallel trends assumption may be due to a form of 'treatment anticipation' where donors already somewhat increase their donation frequency before joining a group. This is confirmed by the test for treatment anticipation using the indicator for joining a group in the next year ($p < 0.001$). To offset this pattern of 'treatment anticipation', we drop data for the problematic anticipation period right before joining a group for each donor and re-estimate models 1-3. Figure 5.3 and the robust Wald test (see column 6 of Table 5.2) show that there no longer is a violation of the parallel trends assumption. Joining a group is again estimated to strongly increases donation frequency in the first two years after

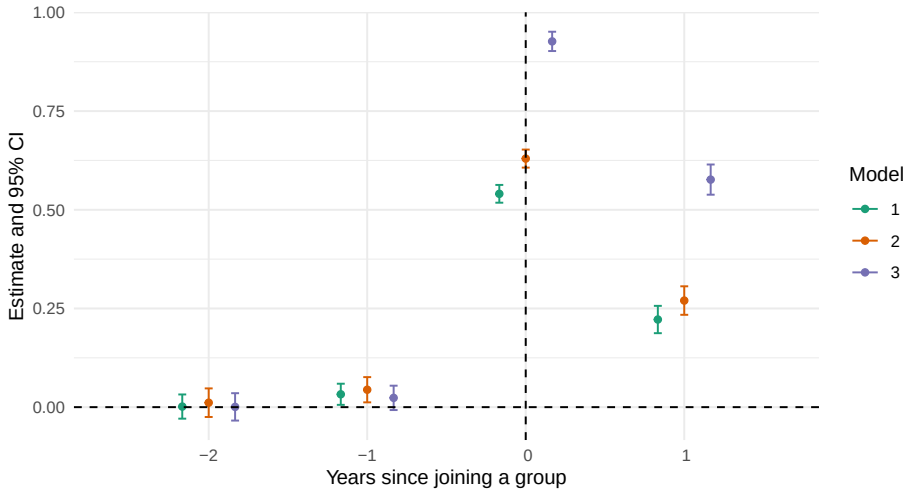


**Figure 5.3** Event-study estimates of the effect of joining a group on donation frequency with the period prior to joining a group excluded for each donor to offset anticipatory effects.

Notes: This figure presents the estimates from the event-study regression where the period just before joining a team is excluded from the data set to offset anticipatory effects. Parameters for post-treatment periods are derived from specifications that do not include the pre-treatment estimates to avoid the problem of biased treatment effect estimates after pre-testing (Borusyak et al. 2022; Roth 2022; Sun and Abraham 2021). Model 1 is estimated without covariates. Model 2 includes age, gender, and state fixed effects as pre-treatment covariates. Model 3 includes experience, habit, deferral, and whole blood donor status as additional covariates to those included in model 2.

joining a team. However, accounting for treatment anticipation in this way means that we can only provide estimates for a shorter time horizon.

Table 5.2 presents the overall estimate of the effect of joining a group on donation frequency for the different model specifications. Note, however, that the results from models 1-3 cannot be interpreted as causal effects, since the parallel-trends assumption is unlikely to hold. Our preferred specification is therefore model 4, which corrects for the violation of parallel trends and still allows us to obtain estimates for up to three years after joining a team. This longer time horizon seems important given the strong decrease of the estimated effect over time. Based on model 4, joining a group is estimated to increase donation frequency by about 37% ($e^{0.313} = 1.368$) in the three years after joining a group.

**Table 5.2** Effect of joining a group on donation frequency

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Post joining a team | 0.271 | 0.305 | 0.498 | 0.314 | 0.249 | 0.81 |
| | (0.009) | (0.011) | (0.01) | (0.02) | (0.022) | (0.014) |
| Interaction team activity | | | | | 0.016 | |
| | | | | | (0.005) | |
| Pretrends p-value | <0.001 | <0.001 | <0.001 | | | 0.291 |
| Observations | 433272 | 433272 | 433236 | 433236 | 325590 | 361030 |
| Cohort & year dummies | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sociodemographic controls | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Additional controls | | | ✓ | ✓ | ✓ | ✓ |
| Cohort-specific trends | | | | ✓ | ✓ | |

Notes: This table presents the overall effect of joining a group on yearly donation frequency. Displayed are coefficients from a Poisson regression. Model 1 is estimated without covariates. Model 2 includes age, gender, and state as pre-treatment covariates. Model 3 includes experience, habit, deferral, and whole-blood donor status as additional covariates to those included in model 2. Model 4 additionally accounts for cohort-specific linear time trends, which serves as a correction for a violation of the parallel trends assumption. Model 5 includes the interaction with the team activity variable. Model 6 drops all observations for the year just before a donor joins a team to counteract anticipatory effects (Wooldridge 2023). In comparison to the other models, model 6 estimates the effect including two instead of three years after joining a team.

### 5.5.1 Heterogeneity by group activity

Column 5 in Table 5.2 shows the estimate for the interaction effect of joining a group with the group activity variable. Joining a group where members on average make one more donation per year is estimated to boost the effectiveness of joining a group by approximately 1.6%. For this sample of donors who joined a team that already existed in the year before they joined, it is estimated that joining a team increases donation frequency by about 28%. A donor that joins a group where the average donation frequency is one standard deviation above the mean would therefore increase their donation frequency by approximately 31%, while a donor that joins a team that is one standard deviation below the mean in terms of donation activity would increase their donation frequency by about 25%. Figure 5.4 further shows that the benefit of joining a more active group is relatively constant throughout the duration of group membership.

### 5.5.2 Robustness checks

Below, we report on several robustness checks demonstrating the robustness of the findings from the preregistered analyses to a) an alternative construction of the primary outcome variable with higher temporal resolution, b) an alternative sample that excludes potential group founders, and c) the use of alternative estimation strategies.

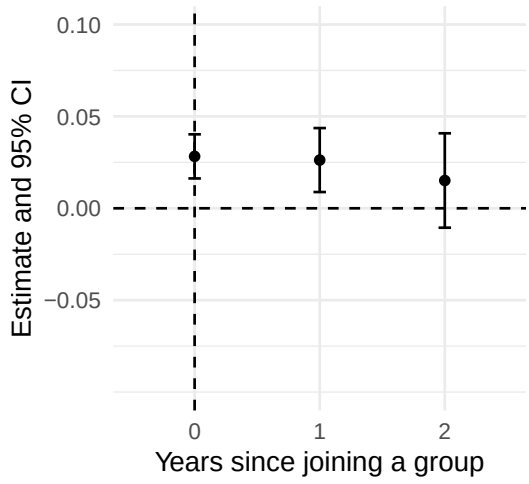


**Figure 5.4** Heterogeneous effects by group activity.

Notes: This figure presents the estimates estimates of $\zeta_{gs}$ in Equation 5.1 based on Model 4, showing how the effect of joining a group varies by group activity and time since joining a group. The group activity variable was standardised such that it has a mean of zero and a standard deviation of one.

### Higher temporal resolution

While aggregating data to the yearly level is intuitive and provides a tangible interpretation to the measure of donation frequency, it is somewhat arbitrary. We therefore additionally apply the DiD estimation to data aggregated on the monthly level (reported below) and half-yearly level (see Appendix section A5.2). This higher temporal resolution provides a robustness check and provides more insights into the temporal dynamics of the estimated effects.

Plotting donation frequency on the monthly level (see Figure 5.5) shows that several years before joining a team, donation frequency is relatively stable at about 0.15 donations per month. In the months before joining a group, donation frequency already slowly increases from 0.15 donations to about 0.25 donations. In the month that donors join a group, average donation frequency jumps from approximately 0.25 donations per month to an average of almost one donation per donor in the month of joining a group. This initial spike is because as some donors sign up for a group, they also register for their first group donation appointment at which they donate together with other members of the group. For these group appointments, which are planned by the group's 'champion'[7], there is a deadline for submitting the list of participants for the group donation appointment up to

[7]These champions are members of the group who take a coordinating role. They take an active role in recruitment of new members, communication between the blood bank and the remaining group donors, and they can book appointments for group donations.

14 days prior to the group donation appointment. If the participants for the group appointments have not been confirmed 2 weeks prior to the appointment, the community relations assistants employed by Lifeblood are additionally instructed to reach out to the group's coordinators. This results in many donors making a donation exactly 14 days after joining a group, as can be seen in Appendix Figure A5.4. After initially joining a group, donation frequency remains significantly higher than before joining a group, but levels off at around 0.2 donations per month up to 4 years after initially joining a group.

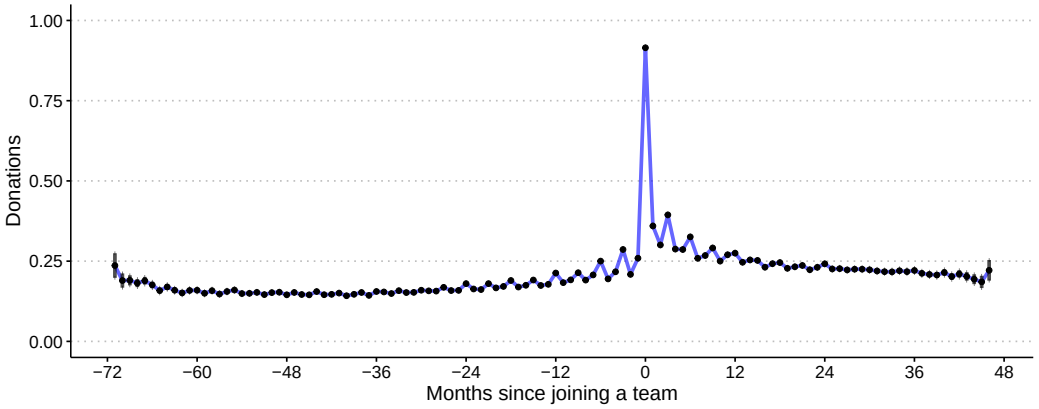


**Figure 5.5** Monthly donation frequency relative to the date of joining a group.

Notes: This figure shows the average monthly donation frequency for donors in our sample relative to the day that they joined a group for up to 72 months before joining a group and up to 48 months after joining a group, which is the time range covered in our sample.

Estimating the DiD model on the monthly level (see Figure 5.6) shows that compared to those that did not yet join a team, monthly donation frequency increases by about 0.4 donations in the first and second month after joining a team, remains significantly higher (approximately 0.05 donations or 30% higher) than in the comparison group for 16 months, and is generally not statistically significantly different from 0 between the $16^{th}$ and $34^{th}$ month after joining a group[8].

The results from the analysis on the monthly level suggest that two processes contribute to the strong increase in donation frequency that we observe in the first year. One is that some donors join a team together with signing up for a group donation appointment, and the other is the general positive effect of joining a team which continues to persist for about 1.5 years after initially joining a team.

[8]Here, we used the Callaway and Sant'Anna (2021) estimator as described in Figure 5.5.2. This model was specified using calendar months as compared to months relative to the join date as in Figure 5.5, which means that the donations on the $14^{th}$ day after joining a team (shown in Appendix Figure A5.4) may fall into calendar month zero or one after joining a team.

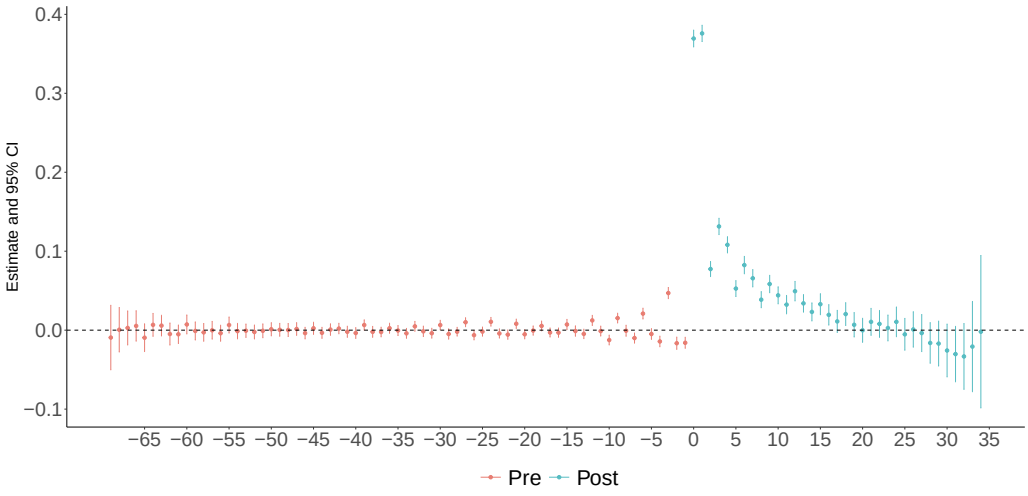


**Figure 5.6** Event-study estimates of the effect of joining a group on monthly donation frequency.

Notes: This figure presents the event-study estimates based on the Callaway and Sant'Anna (2021) estimator without covariates. The model accounts for 12 anticipation periods to offset anticipatory effects.

### Alternative sample excluding group founders

The results of model 5 used to test the interaction effect with team activity (see column 5 of Table 5.2) provide an additional sensitivity check for hypothesis 1, since they rely on a different subsample of donors. This specification uses a sample of donors who joined a group that already existed in the year before the donor joined. Therefore, donors who created a group themselves are excluded (since there is no data for their group's average donation in the previous year). The estimates provided in this sample therefore show to what extent the results extend to donors that only join a group as opposed to those that might be involved in the foundation of a group and those that immediately join with the creation of the group. Both founding or immediately joining a group may be expected to more strongly increase donation frequency. However, compared to the same model applied to the total sample (model 4), the estimate is only slightly reduced to about a 28% increase in donation frequency. This shows that the estimated effect is due to donors joining a group rather than becoming motivated to create a group.

### Alternative estimation strategies

As a robustness check for the test of hypothesis 1, we additionally apply the DiD estimator developed in Callaway and Sant'Anna (2021) to our data, which has become a recommended and commonly applied approach to estimating DiD models in settings with multiple time-periods, variation in treatment timing, and potential treatment effect heterogeneity (Baker et al. 2022). This robustness check allows us to test the sensitivity of

our results to functional form assumptions (linear vs. exponential). In addition, the Callaway & Sant'Anna estimator has the benefit that it is doubly-robust. For the estimates to be unbiased, it only requires either the regression adjustment or the inverse probability weighting model that are used to account for selection on observables to be correctly specified (whereas our main estimation procedure relies on regression adjustment alone). The results are in line with those obtained from the Poisson DiD estimator (see Appendix Figure A5.7).

In addition, we use the synthetic differences in differences (SDiD) estimator developed in Arkhangelsky et al. (2021). In comparison to DiD, SDiD does not rely on the parallel trends assumption because it re-weighs observations from the control group to create parallel trends with treated observations. For the SDiD estimation, we use the final cohort as control group, and drop the last period (as there is no control group in the last period) and the second to last period (to avoid contamination by treatment anticipation) in the data. We then apply the SDiD estimator to each of the yearly and half-yearly cohorts. Appendix Figure A5.8 and Appendix Figure A5.9 show the results from the SDiD estimation. The results are in line with our main findings, and show that joining a team strongly increases donation frequency and that the strength of the effect decreases over time.

### 5.5.3 Exploratory analyses

In exploratory analyses, we examine additional dimensions of heterogeneity in the effect of joining a group. In addition, we examine whether an increased likelihood of deferral may be responsible for the observed pattern of a decreasing effectiveness of group membership.

#### Additional dimensions of heterogeneity

Figure 5.7 shows estimates of heterogeneous effects based on the donors habit, experience, age, gender, whole blood donor status, and deferral. The results show that joining a group more strongly increases donation frequency for both male (by about 5%) and older donors (by about 12% more per standard deviation increase in age). In particular, male donors and older donors seem to be less prone to the decrease in the effectiveness of joining a group over time. Further, joining a group seems to increase donation frequency more strongly for more experienced donors (by about 7% more per standard deviation increase in experience).

In contrast, joining a group seems to be significantly less effective for those that already have a stronger current habit of donating blood (by about 40% less effective per standard deviation increase in habit), significantly less effective for those that have a higher proportion of whole blood donations prior to joining a group (by about 50% less effective per standard deviation increase in WB-donor status), and about 20% less effective for those that had been deferred in the two years prior to joining a group.

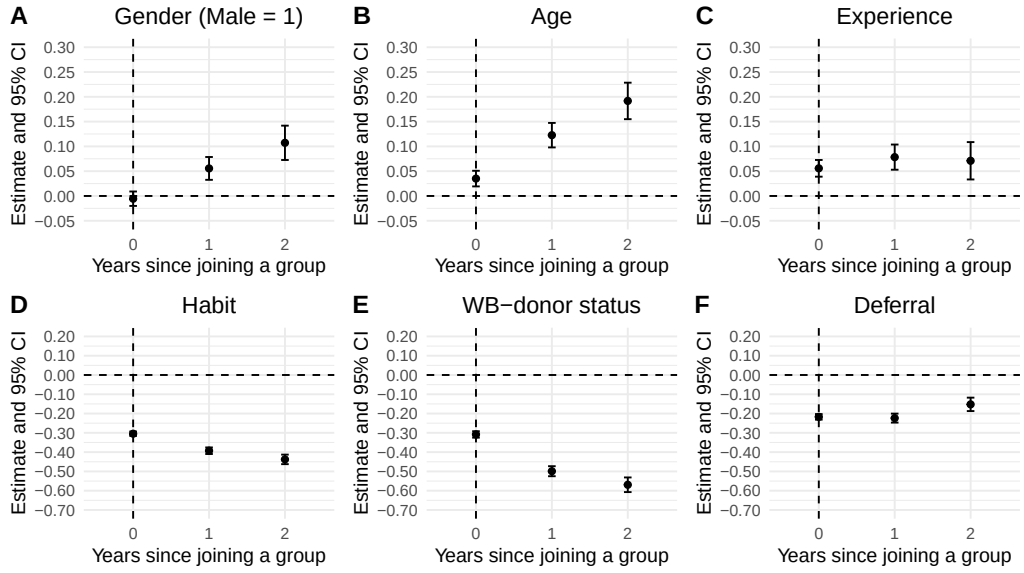


**Figure 5.7** Heterogeneous effects along multiple dimensions.

Notes: This figure presents the estimates estimates of $\zeta_{gs}$ in Equation 5.1, showing how the effect of joining a group varies along the donors' baseline characteristics. All covariates were standardised such that they have a mean of zero and a standard deviation of one.

### Does joining a group affect deferral rates?

One explanation for the decrease in the effectiveness of group membership over time may be that the strong increase in donation frequency leads to higher rates of low haemoglobin (Hb) deferral. Low Hb deferral occurs when the on-the-spot measurement of the Hb level falls below a predefined cutoff. Low Hb deferral is one of the most common reasons for deferral, and the likelihood of falling below the cutoff increases with increased donation frequency since blood iron is lost with every donation (Sweegers et al. 2020). Such temporary deferral does not only mean that blood cannot be drawn on this occasion, but also reduces future blood donation frequency (Bruhin, Goette, Haenni, Jiang, et al. 2020; Clement et al. 2021). Figure 5.8 plots the proportion of donors who were deferred at least once by cohort. It shows that for each of the cohorts, the proportion of deferred donors indeed increases slightly in the year after joining a group.

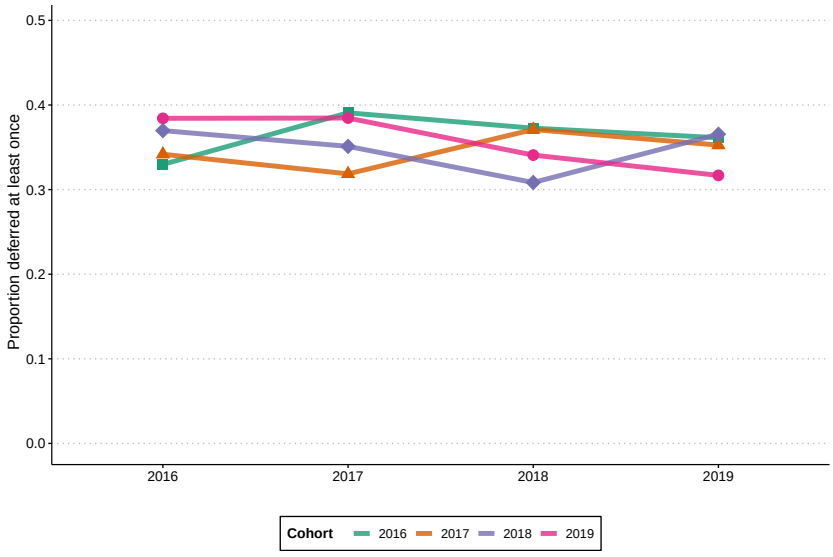


**Figure 5.8** Proportion of donors deferred at least once by cohort.

Notes: The sample includes only those observations where at least one donation attempt was made, since donors that did not make an attempt cannot be deferred.

## 5.6 Discussion and conclusions

This study has analysed how joining a group of donors affects prosocial behaviour in the form of blood donation. Supporting our main preregistered hypothesis, the results provide evidence that joining a blood donor group strongly increases donation frequency. Based on our preferred model specification, joining a group is estimated to increase donation frequency by about 37% in the three years after initially joining a group. However, our results also show that the positive effect on donation frequency levels off over the course of approximately two years: while joining a group increases donation frequency by about 90% in the year that a donor joins a group, donation frequency is only about 14% higher in the second year after joining a group, and even by about 30% lower than that of the comparison group two years after a donor initially joins a group. We provide several robustness checks for our results, which all indicate that joining a blood donor group significantly increases donation frequency. Breaking the analysis down to the monthly level further showed that the strong effect of joining a group is in part due to a group donation appointment that some donors sign up for when they join a group and leads to a strong jump in donation frequency in the first month after joining a team, and in part due to an overall increase in monthly donation frequency in the months after joining a group that lasts for approximately 1.5 years after first joining a group. In addition, we showed that, in line with our second preregistered hypothesis, joining a more active group more strongly increases donation

frequency than joining a less active group, by about 2.5% more per standard deviation increase in average donations by other group members.

In exploratory analyses, we were able to test one possible explanation for the decreasing effectiveness of group membership over time, namely increased medical deferral. Several characteristics that are typically associated with a lower sensitivity to haemoglobin-based medical deferral (being male, older, and donating plasma rather than whole blood) increase the effectiveness of joining a group, and specifically mitigate the decrease in the effect of joining a group on donation frequency over time. Looking at deferral rates for cohorts over time, we also see that the probability of being deferred increases in the periods after joining a team. These findings suggest that the decrease in the effectiveness of joining a group over time may be due to the increased deferral following the initial increase in donation frequency. However, there are other explanations that are in line with the pattern of decreasing effectiveness, which we are not able to test based on our data. For example, donors might informally leave their group, be disappointed with the process of group donations, or the salience of group membership might simply decline over time.

There are some limitations of our study, which represent opportunities for future research. First, our results do not allow us to speak to additional mechanisms that may explain why joining a blood donor group increases donation frequency, such as the formation of a shared identity, intergroup competition, a simple reminder function, or default-nudges through group-donation appointments. The formation of a shared identity may lead to blood donation being understood as a contribution to the group, which may increase donations due to in-group favouritism (Balliet et al. 2014), intergroup competition has been shown to be effective in a case study on one of the teams in the Lifeblood teams programme (Bryant et al. 2023), and reminders seem to increase the probability of donation by about 10% (Bruhin et al. 2015). Given the large effect size that we find, it is likely that a combination of these mechanisms contributes to the effectiveness of the programme. Future work could explore these mechanisms through the use of field experiments or qualitative research. Second, our study identifies the effect of joining a group on donation frequency rather than the effect of currently being in a group. Although this implies reduced comparability to laboratory experiments, this effect is arguably more interesting for practice: it shows the effectiveness of the intervention while accounting for the fact that many donors might not stay engaged with their group. Keeping donors engaged in these groups might require an additional set of interventions. Finally, a remaining limitation to interpreting our findings as causal is that donors might self-select into groups and into more active teams based on their intended future donation behaviour (rather than their current behaviour, which is accounted for in our models).

An interesting avenue for future research would be to examine whether a group membership programme might be helpful for the recruitment of new donors. Because of the natural upper limit to donation frequency imposed by health considerations (Haugen et al.

2024; Van Remoortel et al. 2023), there is a constant need to recruit new donors. Sun et al. (2019) have previously shown that donors can be motivated to use their social networks for the recruitment of new donors if provided with group rewards. Offering such incentives within the context of a group donation programme could combine the strengths of both interventions in terms of recruitment and retention of blood donors. Another interesting question for future research would be to what extent our findings might translate to other domains of prosocial behaviour. Blood donation might be particularly suited for a group-membership programme to work, for example because it facilitates in-person interaction. However, the results from empirical studies on prosocial lending suggest that in-person interaction might not be necessary for group-formation to be an effective strategy for increasing prosocial behaviour. The suggested mechanisms by which joining a group of other contributors increases donation frequency (conditional cooperation, group identification, ...) may be active for others forms of cooperation, such as charitable giving, volunteering, and climate-friendly behaviour.

This study makes three main contributions to the literature and practice. First, our study contributes to the field of strategies and institutional design for motivating prosocial behaviour and blood donation behaviour in particular (Chell et al. 2018; Dannenberg and Gallier 2020; Godin et al. 2012; Southcott et al. 2022; Stutzer et al. 2011; Sun et al. 2019). Our paper shows that the strategy of group formation among contributors works in the field, at societal scale, and even for the case of the repeated high-cost prosocial behaviour of blood donations. This finding goes significantly beyond the results of previous studies in the field, which had shown that group formation works to increase the lower-cost prosocial behaviour of prosocial lending in the field (Ai et al. 2016).

Second, this study makes a contribution to literature on group formation and cooperation. Numerous studies have shown that group formation can be beneficial in experimental settings where there are strategic interests for the individual to contribute (contributions to club goods) (Guido et al. 2019; Gunnthorsdottir et al. 2007). In this paper, we show that the formation of identity-based groups can also promote contributions to a public good that benefits society at large and when there is little strategic interest in contributing to the public good. Further, our finding that joining a more active team more strongly increases donation frequency than joining a less active team is in line with previous experimental studies (Gunnthorsdottir et al. 2007; Otten et al. 2022), and suggests that conditional cooperation may be partly responsible for the effectiveness of group membership for increasing prosocial behaviour in the context of blood donation.

Finally, the evidence provided in this paper is instrumental in informing the practice of blood banks and other organisations that rely on the repeated contributions of individuals, such as organisations in the field of charitable giving or volunteering. It can support decision-making in organisations that have already implemented programmes that make use of group formation (e.g, Lifeblood and Kiva.org), and organisations aiming to imple-

ment similar strategies in the future. Our results show that such programmes can be very effective, leading to a substantial increase in donation frequency. At the same time, our results demonstrate that there is a need for a close monitoring of its effects and potential follow-up interventions (for example, targeting the salience of group membership in the long run) to maintain the effectiveness of the programme. To boost the effectiveness of such programmes, it may further be fruitful to provide information about the active donation behaviour of other group members to make use of the mechanism of conditional cooperation.

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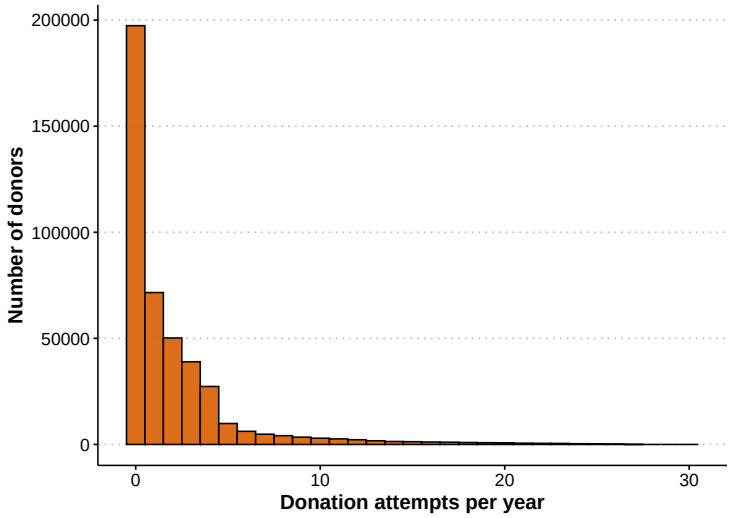
# Appendix A5

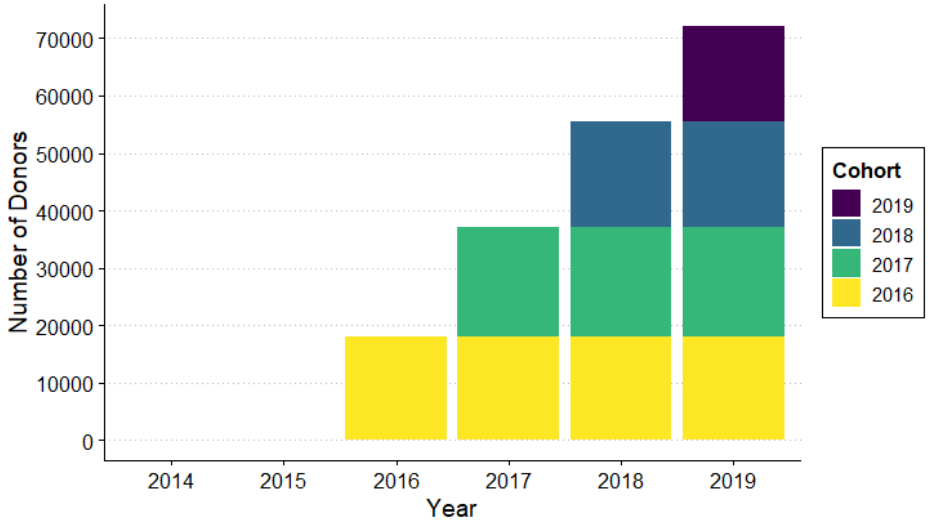
## A5.1 Details on variables

Figure A5.1 shows a histogram for the primary outcome variable, namely the yearly number of donation attempts. Figure A5.3 shows the distribution of the group activity indicator for each of the cohorts.

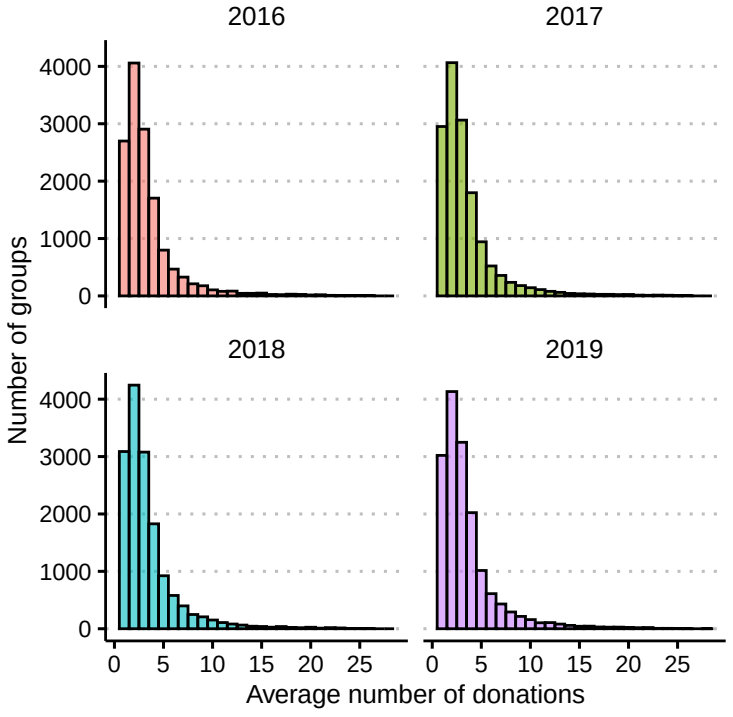
Figure A5.2 shows the 4 yearly cohorts and their size.




**Appendix Figure A5.1** Histogram of the donation attempts per year. N = 433272 donor-year observations.




**Appendix Figure A5.2** Cohort size

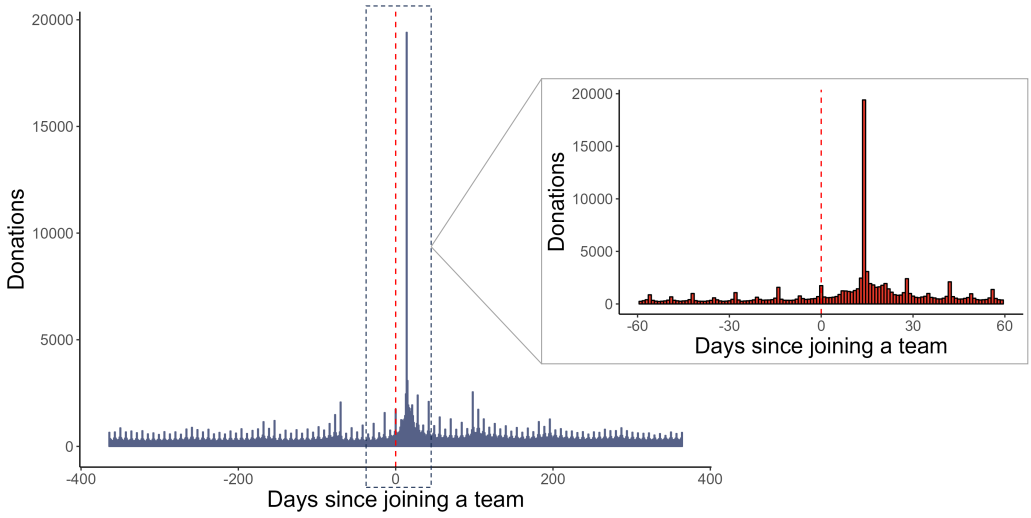



**Appendix Figure A5.3** Group activity by cohort.

**Appendix Table A5.1** Construction of study measures

| **Variable** | **Definition** |
|---|---|
| Age | The donors age in years at the point of joining a team. |
| Sex | The donors sex, as reported to the blood bank. 0 = female, 1 = male. |
| Deferral | Donors sometimes have to be deferred from making a donation for medical reasons, such as low haemoglobin levels. Donors that have been deferred before are more likely to be deferred again, and they might therefore be on different trends of donation frequencies than those that have not been deferred before. We construct a variable indicating whether a donor has been deferred in the two years prior to joining a group. |
| Habit | The donors current habit of donating blood is measured by the number of donations made within the two years prior to joining a group. |
| Experience | Experience as a blood donor is measured by the years since registration as a donor. |
| Whole blood donor status (WB-donor status) | Whole blood can be donated every 12 weeks, while plasma and platelet (apheresis) donations can be made every two weeks. Whether a donor was primarily a whole blood donor or plasma or platelet donor is measured by the proportion of whole blood donations out of the total donations prior to joining a group. This is a slight deviation from the preregistration, where we specified to use only the donations in the two years prior to joining a team to create this variable. However, that would lead to a large number of missing observations because not every donor made donations in the two years prior to joining a team, and we therefore use all previous donations to create this variable. |

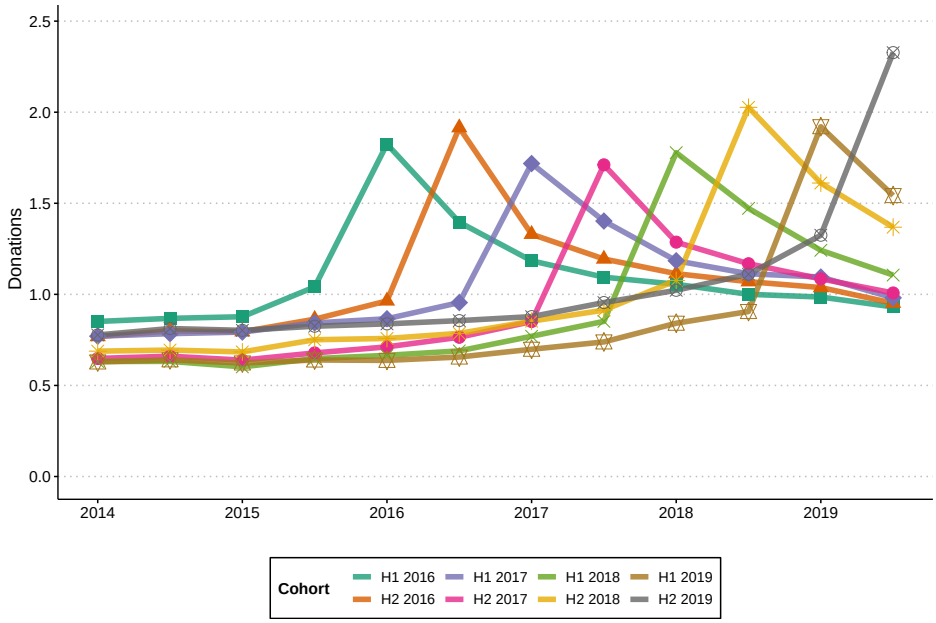
## A5.2 Higher temporal resolution



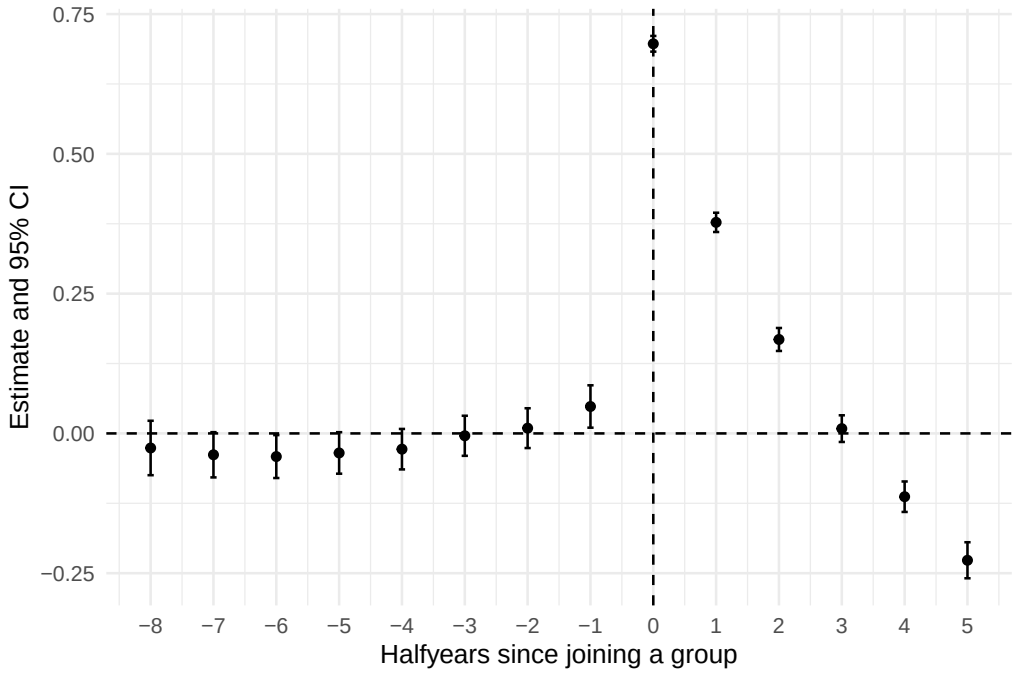

**Appendix Figure A5.4** Number of donation attempts per day relative to the date of joining a group.

Notes: This figure shows all donation attempts relative to the date that donors joined a group for a 2-year window around the date of joining a team (left), and for a 120-day window around joining a team.

Figure A5.5 shows donation frequency over time by half-yearly instead of yearly cohorts. Similar to Figure 5.1, it shows a pattern of increasing donations in the year where a cohort joins a team, and a decrease in the size of the effect over the following periods. Figure A5.6 shows the results from estimating the event-study specification without covariates using half-yearly cohorts, and with the period prior to joining a group excluded for each donor to offset anticipatory effects. Again, the results show a strong increase of donation frequency after joining a team by about 29%, and the pattern of decreasing donation frequency compared to the comparison groups several periods after initially joining a team.



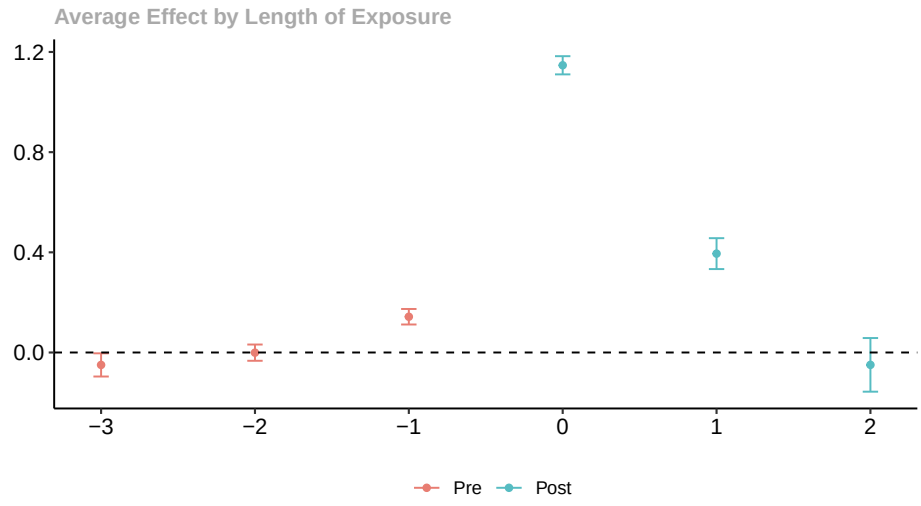

**Appendix Figure A5.5** Donation frequency by cohort for half-yearly cohorts.




**Appendix Figure A5.6** Event-study estimates of the effect of joining a group on donation frequency for half-yearly cohorts.

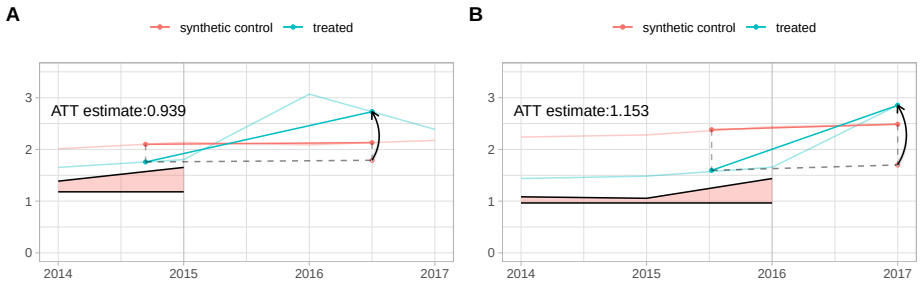
Notes: This figure presents the estimates from the event-study specification without covariates applied to half-yearly cohorts, and with the period prior to joining a group excluded for each donor to offset anticipatory effects. Parameters for post-treatment periods are derived from a specification that does not include the pre-treatment estimates to avoid the problem of biased treatment effect estimates after pre-testing (Borusyak et al. 2022; Roth 2022; Sun and Abraham 2021).

## A5.3 Alternative estimation strategies



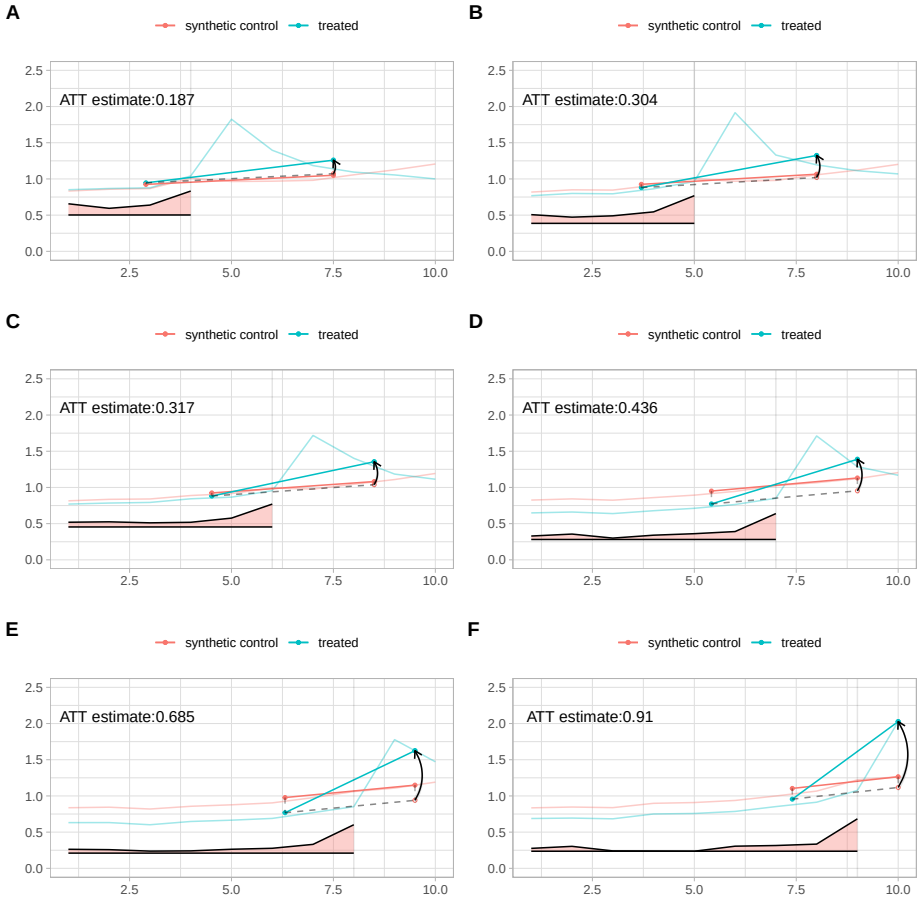

**Appendix Figure A5.7** Robustness check using the doubly robust Callaway and Sant'Anna (2021) estimator.

Notes: This figure presents the event-study estimates of the effect of joining a group on donation frequency by time since joining a group using the the doubly robust Callaway and Sant'Anna (2021) estimator. As model 3 in Table 5.2, the estimation includes age, gender, state fixed effects, experience, habit, deferral, and whole blood donor status as pre-treatment covariates.




**Appendix Figure A5.8** Robustness check using synthetic differences in differences (Arkhangelsky et al. 2021).

Notes: This figure presents the ATT estimates for each cohort from a synthetic differences in differences estimation. The period just before joining a group is indicated by a grey line.




**Appendix Figure A5.9** Robustness check using synthetic differences in differences (Arkhangelsky et al. 2021) applied to half-yearly cohorts.

Notes: This figure presents the ATT estimates for each half-yearly cohort from a synthetic differences in differences estimation. The period just before joining a group is indicated by a grey line.

# Chapter 6

# General discussion

One of the biggest challenges in research on cooperation and prosocial behaviour is to identify strategies that enable the sustained provision of public goods. While a large number of laboratory experiments have identified social mechanisms that promote sustained contributions to public goods, it is largely unclear to what extent findings from these studies translate to the real world. This thesis aimed to fill this gap in the literature by empirically studying real world cooperation in the form of blood donation. Specifically, this thesis has studied how the social mechanisms of social contagion, communication, and group formation affect real-world cooperation, and how NPOs, specifically blood banks, can make use of such social mechanisms to facilitate cooperation. In many countries, including the two countries under study in this thesis, the Netherlands and Australia, blood donation systems resemble a textbook case of costly private altruistic contributions to a public good. It is therefore an ideal setting to test theories of sustained cooperation and prosocial behaviour in the real world.

The first empirical chapter of my thesis, Chapter 2 *'Who gives life?'*, has tackled the question whether there are distinct types of blood donors based on a large set of known determinants of blood donation behaviour. Synthesising previous individual-centred literature, I used mixture modelling to develop a tangible classification of blood donors that is both theoretically informative and that may be used by blood collection organisations aiming to tailor their retention strategies to specific groups of donors. I identified four distinct types of donors that vary in their motivations, socio-demographic characteristics, and long-term donor lapse: the exceptionally motivated donors (18%, high motivation across constructs, 42% lapse), the unfulfilled donors (23%, low motivation across constructs, 62% lapse), the balanced donors (33%, average motivation across constructs, 45% lapse), and the confident habitual donors (26%, high on self-efficacy and habit formation, average on other constructs, 40% lapse). In addition, Ifound that donors often transition between

these types over time and in relation to the crucial life-event of childbirth. Extending previous theoretical models of repeated blood donation behaviour, I showed that to understand donor retention, we should consider both cross-sectional heterogeneity and longitudinal heterogeneity in donor motivations. Relevant for blood banking practice, I showed that self-efficacy and habit formation are particularly important characteristics of donors that are more likely to be retained for a long time. I therefore echoed recommendations of previous literature to make blood donation easy and convenient. Furthermore, I found that donors that signed up on their own initiative are typically in the more motivated classes, especially when compared to those that were recruited via traditional marketing campaigns (brochures, newspapers, or internet). For blood banks, it might therefore be worth trying to increase the potential for self-selecting into becoming a blood donor through broad appeals and providing donors with a sense of ownership.

Chapter 3 *'The social contagion of prosocial behaviour'*, analysed to what extent conditional cooperation within neighbourhoods affects repeated blood donation behaviour, and which psychological mechanisms can explain this relationship. The results showed that blood donors behave in a conditionally cooperative way: they increase or decrease their contributions based on the donations made by others. The analysis attributed social contagion within neighbourhoods to couples of donors, and therefore showed that it is social networks rather than spatially defined communities which are important for social contagion of blood donation. Furthermore, I did not find evidence that this conditional cooperative behaviour works through normative social influence — an influence to conform with the positive expectations of another — or informational social influence — accepting information obtained from another as evidence about reality. More specifically, I did not find that constructs hypothesised to capture these social influences, namely subjective norms, self-identity, moral norms, awareness of need, or cognitive attitudes, mediated the social contagion effect. For theories of real-world prosocial behaviour, the results imply that social contagion should be considered as an additional relevant explanatory factor. For blood banking practice, the results imply that retention efforts are likely to be more successful when targeted at groups of donors.

Chapter 4 *'Did you donate?'*, reformulated the problem of giving blood from an organisational point of view and studied social influences on compliance with solicitations for donations. We built on the insight that many forms of prosocial behaviour (blood donation, charitable giving, volunteering) are highly institutionalised, and that much of the prosocial behaviour we observe in the real world is therefore not spontaneous giving but the result of organisational efforts, such as solicitations for donations. In this chapter, I have drawn on theories of social-ecological systems and studied how recruitment via word of mouth (WOM) and talking about donations relate to compliance with these solicitations for donations. I found that talking about donations predicts compliance with solicitations for donations, and that this association is moderated by donor experience, such that it is

strongest for novice donors with few previous donations. In addition, I found that donors recruited via WOM have similar compliance rates to donors recruited via traditional channels (brochures, newspapers, or internet). The primary contributions of the study to theory are to recognise solicitations for donations as a distinct level of analysis, and to demonstrate the social embedding of the donors' decision making processes about compliance with such solicitations. For practice, the results imply that to increase compliance with solicitations for donations, blood banks could make use of strategies aimed at increasing communication about blood donation among their donors and novice donors in particular.

In the final empirical chapter, Chapter 5 *'How group membership affects prosocial behaviour'*, I evaluated an intervention set up to make use of social mechanisms such as those identified in the previous chapters: a nationwide group membership programme for blood donors in Australia. Drawing on data for the population of blood and plasma donors in Australia, I provided quasi-experimental estimates for the effect of joining a blood donor group on donation frequency. The results have shown that the strategy is highly effective. Joining a team increases donation frequency by about 37% when compared to a control group that joins a team at a later point in time. Chapter 5 further analysed heterogeneity in the effectiveness of the programme, and potential barriers to its long-term sustainability. Contributing to the field of strategies and institutional design for motivating prosocial behaviour, I have shown that the strategy of group formation among contributors works in the real world, at societal scale, and even for the case of the repeated high-cost prosocial behaviour of blood donations. Adding to the literature on group formation and cooperation, I have shown that the formation of identity-based groups can also promote prosocial behaviour when there is little strategic interest in contributing to the public good. Contributing to practice, the results showed that group formation can be very effective, but also that there is a need for a close monitoring of its long-term sustainability and potential follow-up interventions to increase the salience of group membership.

In the following sections, I discuss the contributions of this thesis to research (section 6.1), contributions to blood banking practice (section 6.2), the challenges and opportunities that lie in bridging research and practice (section 6.3), strengths and limitations of the research conducted within this thesis (section 6.4), and implications for future research (section 6.5).

## 6.1 Contributions to research

This thesis has made several contributions to empirical knowledge and theoretical understanding of blood donation, cooperation, and prosocial behaviour. I have embedded these contributions in various theoretical models. Chapters 2, 3 and 4 have drawn on theoretical models building on the Theory of Planned Behaviour (TPB), aimed specifically at

explaining repeated blood donation behaviour (Ajzen 1991; Masser et al. 2008; Piliavin et al. 2002). Chapter 3 is additionally motivated by game-theoretical models of cooperation (Chaudhuri 2011; Kollock 1998), and makes a connection to theoretical models of social influence (Deutsch and Gerard 1955; White et al. 2009). Chapter 4 has drawn on theories of social-ecological systems (McGinnis and Ostrom 2014; Ostrom 2010; Schlüter et al. 2017), and developed a social-ecological systems model that integrates TPB models of individual blood donation behaviour into their broader social and physical context. Chapter 5 has more explicitly drawn on the experimental literature on cooperation and group formation (Gächter and Thöni 2005; Guido et al. 2019; Gunnthorsdottir et al. 2007), which is typically analysed using game-theory and embedded in rational choice models of human behaviour (Ostrom 1998). Throughout these chapters, we have made several contributions by empirically testing hypotheses derived from these models, by integrating different existing theoretical models, and by extending some of the models based on the findings. The individual chapters have each discussed their contribution to the underlying theoretical model. Below, I discuss contributions to research that go beyond the chapters' individual contributions.

### 6.1.1 Embedding blood donation research in social context

The main contribution of this thesis is to conceptually and empirically link the individual-centred blood donation literature with the experimental literature on social mechanisms that sustain cooperation.

The empirical chapters have studied three social mechanisms identified as influential in previous experimental literature in the context of blood donations as an ideal-typical real-world example of cooperation. Broadly speaking, this thesis has shown that these mechanisms are relevant for understanding cooperation in the real world and that these mechanisms can be used by societal actors, specifically blood banks, to facilitate sustained cooperation. After Chapter 2 identified a gap in the literature with regards to how social mechanisms operate in blood donations, Chapters 3 and 4 have focussed on two of the most powerful mechanisms sustaining cooperation in social preference games, namely conditional cooperation and communication between (potential) contributors (Kudo et al. 2024). In both chapters, I explicitly made a connection between the experimental and individual-centred literature: Chapter 3 has shown that the influence of conditional cooperation on blood donation is not captured by normative and informational social influences on attitudes towards blood donation behaviour that originate in the individual-centred blood donation literature; Chapter 4 has shown that talking about blood donations measured on the individual but not the collection site level predicts compliance with solicitations for donations. Building on Chapters 3 and 4, Chapter 5 showed that another social mechanism, namely group formation among contributors, is highly effective in increasing donation fre-

quency. By demonstrating that these mechanisms are at work in real-world cooperation, this thesis also tackles an important limitation in the experimental literature on social mechanisms, that is, the limited knowledge about the generalisability of the findings to the real world. In this thesis, I focussed on a highly important example of cooperation in the real world that in many respects resembles a public goods game. In doing so, I have shown that these mechanisms are relevant when we do not abstract from the 'messiness' that exists in the real world.

Linking the literature on social mechanisms with the individual-centred literature on blood donation shows how individual-level factors shape the effectiveness of social mechanisms. For example, I found the susceptibility to social influences via communication to be lower among more experienced donors. In addition, factors that we know to be important from previous individual-centred work are also relevant to the operation of social mechanisms: In Chapter 5, I also found that habit formation and factors related to individual capacity to donate are important moderators of the effectiveness of the social mechanism of group formation.

Another contribution of this thesis is to move away from studying individual-level correlates of blood donation behaviour, and towards a more structural understanding of its social embedding and structural interventions. While previous individual-centred literature in tradition of the TPB has led to a good descriptive theory of why people donate blood, it has not typically led to an effective set of interventions (Masser et al. 2020). One reason for this shortcoming may be that many of the constructs included in the TPB are quite hard to change with interventions (Armitage and Conner 2001). This is not to say that interventions targeted at changing these attitudes cannot be effective. In fact, many studies have shown that attitudes such as self-identity as a blood donor can be successfully used in interventions aimed at donor recruitment or retention (Ferguson et al. 2023; Godin et al. 2012; Irving et al. 2020). However, one thing to learn from the literature on social mechanisms that this thesis has brought to the field of blood donations is that we should embed the descriptive theories of blood donation behaviour in social context. For example, it might not be necessary to change the attitudes and perceptions themselves, which is often difficult. Instead, we might also be able to use the knowledge about the decision-making process about blood donation behaviour to create interventions that facilitate cooperation because they shape the social and institutional context. For example, the intervention of group membership is not necessarily aimed at changing the inclination of donors to communicate or their competitiveness. In contrast, it changes the institutional structure in a way that makes use of these human tendencies to increase donation frequency.

### 6.1.2 Implications for Theory of Planned Behaviour models

The TPB, as one of the most widely used theoretical models for studying blood donation behaviour (Ferguson et al. 2007; Masser et al. 2020), has been one of the theoretical corner stones of three empirical chapters in this dissertation.

In Chapters 2, 3, and 4, we have drawn on an extension of the TPB by Masser et al. (2008), which focusses on explaining repeated blood donation behaviour. In Chapter 2, we have extended this model by developing a classification of cross-sectional heterogeneity in addition to the heterogeneity in motivations that develops along the trajectory of a career as a blood donor (longitudinal heterogeneity). I have shown that both dimensions are relevant to understanding blood donor behaviour. There is considerable heterogeneity in motivational profiles at one point in time and across the donor career. This indicates that not all donors follow the suggested 'predefined path' from a novice donor motivated by intent, to early career donor motivated by habit, to established donor motivated by donor identity. However, the analyses in Chapter 2 and Chapter 4 also support the model's assertion that it is important to consider the development of donor motivation in line with their experience as a blood donor. I show that more experienced donors are also more motivated across a broad range of constructs included in the extended TPB, including affective attitudes, self-efficacy, habit formation, moral norms, and self-identity as a blood donor. In addition, in line with the model's prediction that donor behaviour is more malleable at the beginning of their donor career, I found that talking about donations is more strongly positively related to the compliance of novice donors, but not to compliance of donors that have gained a lot of experience as a blood donor.

In Chapter 3, I have shown that social contagion of blood donation behaviour is not captured by the constructs included in this extended version of the TPB, namely subjective norms, self-identity, moral norms, awareness of need, or cognitive attitudes. An adaption that could be made within the TPB framework is to include a measure of descriptive norms, as has occasionally been done in previous literature (Costa et al. 2020; Rivis and Sheeran 2003; Robinson et al. 2008; White et al. 2009). In future research, it would be interesting to test whether a descriptive norm construct adequately captures social contagion by testing whether social contagion is (fully) mediated by perceived descriptive norms.

Another interesting insight for this model is that in the data used in this thesis, several constructs, and most notably self-identity, do not have additional predictive power for repeat donation behaviour beyond what is captured by socio-demographic characteristics, habit for donating blood, awareness of need, moral norms, and self-efficacy. In chapter two, I also found that self-identity might not be the most relevant predictor of long-term donor lapse, as donors that are high on self-efficacy and habit formation even have a slightly lower lapse rate than those that are high on all motivational constructs including self-identity. This is interesting given that self-identity in particular was introduced to the

model to better be able to predict repeated blood donation. However, the analysis was conducted using a sample of donors that on average have a relatively high level of self-identity. It may therefore be that the difference between low and moderate levels of self-identity is more important than the difference between moderate and high levels of self-identity as a blood donor.

### 6.1.3 Implications for models of social influence and neighbourhood effects

One of the questions multiple chapters touched upon is which social groups and social connections are the most relevant sources of social influences on repeated blood donation behaviour. When taking the insights on social mechanisms from the laboratory to the field, some factors are not immediately clear: What is the real-world equivalent of the small social worlds that are formed in PGGs? Is it neighbourhoods, collection sites, or social networks? And what group or which social connections should be considered theoretically relevant for the implementation of strategies that are aimed at improving donor retention by making use of social influences?

Chapter 3 and 4 have shown that it is likely not neighbourhoods and collection sites that are prominent spheres in which social influences operate. I found evidence for weak social contagion within neighbourhoods, which could further be attributed to social contagion within donor couples. Furthermore, I did not find evidence that the level of talking about donations or the proportion of donors recruited via word of mouth on the collection site level was associated with the individuals' compliance with solicitations for donations. Notably, blood donation is a physical activity that requires physical presence at a specific location that is shared with many other contributors. Therefore, social influences for other forms of prosocial behaviour (such as charitable giving or online volunteering) may be even less subject to social influence within geographically defined areas. These findings are in line with previous research that has shown that social influences on blood donation do not operate in geographically defined reference groups of other donors, even if these are similar in terms of their observable characteristics (Goette and Tripodi 2024). This does not mean that neighbourhoods or collection sites are generally not relevant contexts for understanding blood donation behaviour. For example, Chapter 4 shows that the composition of the population in terms of age and gender are associated with compliance even if these characteristics are considered on the individual level, and previous research has shown that the distance to the nearest collection site and the characteristics of the collection sites themselves are relevant (Merz et al. 2017; Piersma et al. 2021).

Instead, social mechanisms of blood donation work through social networks. Chapter 3 has shown that partners are important sources of social influence, which is in line with previous research on social contagion in blood donation (Bruhin et al. 2020). Furthermore,

Chapter 5 shows that encouraging donors to form donor groups that are formed around pre-existing social ties, such as at the workplace or among friends and family, can be highly effective for increasing donation frequency. I therefore assume that other parts of the social network and not just partners will also be relevant. In summary, the findings suggest that social proximity is highly relevant for social influence to be at work, and underline the importance of acquiring social network data in relation to blood donation in the future.

## 6.2 Implications for blood banking practice

The primary contribution of this thesis to blood banking practice is to show that blood donors can be influenced by social contagion and talking about donations, and that group formation among blood donors can be an effective strategy to make use of such social mechanisms in blood banking practice.

Based on the finding of social contagion in Chapter 3 and the finding that communication among blood donors increases compliance in Chapter 4, we suggested that group donation programmes might be an effective strategy to improve donor retention and donation frequency. In Chapter 5, I therefore set out to test this hypothesis and found group formation to be a highly effective strategy to increase blood donation frequency.

What other policies could be effective in making use of social interaction effects among blood donors? In Chapter 3, I argued that because of social contagion among blood donors, retention efforts might generally be more effective when they are aimed at groups and, particularly, donor couples rather than individual donors. A direct test of this hypothesis is provided by Bruhin et al. (2020), who show that a simple reminder via phone call is much more effective in increasing donations when targeted at donors that have a partner who is also a donor as opposed to individual donors. One intervention that is popular in the domain of charitable giving is social information, that is, information about other people's behaviour (van Teunenbroek et al. 2020; van Teunenbroek and Bekkers 2020). Such interventions aim to make the cooperative behaviour of others more salient. However, we do not yet know about the best way to implement such strategies in the case of blood donations. As discussed in Chapter 3, there is some evidence for a threshold in the proportion of others that determines whether information about others' donation behaviour positively or negatively affects individual donations (Tsvetkova and Macy 2014). If blood donors behave as conditional cooperators — and Chapter 3 shows that on average they do — information about the low proportion of donors in the population would likely backfire. Instead, blood banks might want to communicate about the high donation frequency of some other donors (Ferguson 2015), or the proportion of people that donate over the course of their life. Based on the finding that social influences operate within social networks as opposed to broader contexts such as neighbourhoods or collection sites, strategies aimed

at leveraging social influences to improve donor retention should most likely make use of pre-existing social ties. Furthermore, strategies aiming to make use of social mechanisms need to consider the specific characteristics of the blood donor population. For example, Goette and Tripodi (2024) have shown that social recognition, a strategy often found to improve cooperation rates, does not seem to be effective in increasing the blood donation rates of existing donors because blood donors do not want to be perceived as image seeking. Finally, based on theory (Masser et al. 2008) and the results of Chapter 4, programmes that make use of communication might be most effective when targeted at novice donors. This is because the behaviour of novice donors is likely more malleable and influenced by external factors than that of very experienced donors. However, Chapter 5 has shown that joining a group seems to more strongly increase donation frequency of those donors that have been donating for longer, suggesting that interventions aimed at making use of social mechanisms might not always be more effective when targeted at novice donors.

Another important insight from Chapter 5 is that it is necessary to consider donor health and the longer-term sustainability of programmes aimed at donor retention and an increased donation frequency. In the evaluation of the group donation programme among Australian blood donors I found that the achieved increase in donation frequency also leads to a small increase in the probability of being deferred in the following years due to low haemoglobin levels. While the programme still seems to be effective overall, policy makers should consider whether this increase in donation frequency puts too much of a strain on donors.

Another recommendation based on findings from Chapters 2 and 3 is that self-efficacy and habit formation are good predictors of long donor careers and repeated blood donation behaviour. To achieve high self-efficacy among donors, interventions should aim to make blood donation easy and convenient, for example by providing donors with easy access to donation sites (Piersma et al. 2021), generous opening hours and a convenient donation experience (Merz et al. 2017), or even making blood donation a truly planned and routine behaviour, e.g., via implementation intentions (if-then plans) (Ferguson et al. 2007), or by offering default appointments.

Finally, the results from Chapters 2 and 4 show that donors recruited via WOM have similar probability of lapsing as well as compliance rates than those recruited via other channels. In an analysis of the relationship between recruitment channel and donor loyalty, Piersma and Klinkenberg (2018) additionally found that donors recruited via WOM have the highest number of donations over the course of their donor career when compared to donors that signed up on their own initiative and those recruited via other channels. Taken together, these results suggest that recruitment via WOM (also discussed as donor-recruits-donor strategies) can be a useful recruitment channel continually replenish the donor population with donors that donate frequently and have long donor carers. In addition, previous studies have shown that current donors are willing to help with the recruit-

ment of new donors (Lemmens et al. 2008), and that they can be supported in doing so via the distribution of evidence-based leaflets and postcards (Lemmens et al. 2010).

## 6.3 Bridging research and practice

Blood collection is a field that is of high scientific and societal relevance and involves many stakeholders, including donors, blood collection organizations, researchers, and recipients of blood products. Researchers and practitioners in the field of blood donor management often work towards the same central goal: ensuring a safe and sufficient supply of blood while keeping donors healthy and happy. However, collaboration between the two groups still seems rare. In September 2023, together with my fellow PhD Candidates Alexandra Ciaușescu and Caroline Graf, we therefore hosted a workshop at the fourth European Conference on Donor Health and Management (ECDHM) in Vienna to identify perceived barriers to collaboration and to facilitate greater collaboration and knowledge-sharing between practitioners and academic researchers.

Participants of the 'Bridging Research and Practice' workshop — researchers and practitioners from many different countries — clearly wished for more collaboration in many domains (see Figure 6.1), including to improve donor health, retention, marketing, recruitment, and donor management. Participants of the workshop also expected that greater collaboration between researchers and practitioners would bring opportunities for mutual learning and the development of practical solutions in donor management that are informed by the latest research. They highlighted that it is important to recognise that there are opportunities for both sides: academics that are interested in learning about real-world cooperation and prosocial behaviour, and for blood banks that are often constrained in the amount of resources that they can spend on development and evaluation of their strategies and activities aimed at donor recruitment and retention.

The main perceived challenges to collaboration are in the areas of communication and mutual understanding, time and resource constraints, data, IT, and bureaucracy, the applicability of research, and agreeing on a problem definition, perspectives and priorities. The challenges are described in more detail in Table 6.1.

What can be done to improve and facilitate collaborations in the future? Regarding learnings from previous collaborations, participants stated the importance of agreeing on a shared language, regular meetings, and keeping each other informed and up to date. Misunderstandings can be mitigated by involving all relevant stakeholders when planning research and policies. Another important aspect is expectation management, which can help to make sure that all participants are on the same page regarding processes and expected outcomes of the collaboration. Another emerging theme is the importance of a clear common problem definition that balances different perspectives and valuing each other's


**Figure 6.1** Responses to the question 'In which areas would you wish for more collaboration?'. Workshop conducted at the ECDHM in September 2023 in Vienna, Austria.

expertise. In terms of communication channels to improve collaboration in the future, participants most commonly mentioned (regular) meetings, a newsletter, or workshops as suitable communication channels to facilitate collaboration in the future (see Figure 6.2). Overall, the responses highlight the need for collaboration with the goal of practical, evidence-based decision making, which can be facilitated by good communication, teamwork, and respect for others' expertise.

One clear avenue for improving the potential for successful collaborations is to tackle the limitation of resource and time constraints, particularly on the practitioner side, for whom collaboration with researchers is typically additional effort that goes far beyond core job responsibilities. If organisations recognise the importance of evidence-based policy making, they should specifically allocate time and resources for research or collaborations with researchers or even employ people in specific positions to facilitate collaboration. For example, science communicators could take a mediating role between researchers and practitioners, translate scientific findings into policy proposals, and guide researchers on track to asking questions of increased policy relevance.

Another avenue could be the broader sharing of data, and especially register data between blood banks and academics. As outlined in the introduction, the analysis of register data can bring many benefits over the analysis of only survey data in terms of coverage of the population of interest and avoiding selection and recall bias. Another aspect of register data that makes it particularly interesting for both academics and blood banking practi-

**Table 6.1** Challenges to collaboration between researchers and practitioners in the field of blood donor management.

| **Challenge** | **Description** |
|---|---|
| Communication and mutual understanding | This includes the use of jargon or discipline-specific language. There is also a lack of shared understanding and appreciation of each other's expertise. |
| Time and resource constraints | Many respondents mentioned that there is a lack of time and funding, that quick results are sometimes prioritised over thorough research and that there are often large delays between starting a study and obtaining results. |
| Data, IT, and bureaucracy | Challenges in this area include difficulties with data sharing, data protection, blood banks data systems, and the availability of suitable data, and more general challenges related to a lack of infrastructure for collaboration. |
| Applicability of research | Results of research can sometimes not be translated into practice and difficult to implement within current blood banking practice. |
| Problem definition, priorities and perspectives | Despite a common core goal, it can be difficult to agree on a common problem definition, and to ensure that the right questions are asked. In addition, there can be differences in scopes, approaches, interest, and priorities that complicate collaboration. |

tioners is that extensive register data is often routinely collected and therefore brings low additional costs. For blood banks, increased sharing of register data could lead to interesting insights into their processes. For academics, register data is a valuable tool for studying cooperation and prosocial behaviour in the real world. For both sides, such a collaboration could be a low-cost and low-risk starting point for a collaborative relationship that can provide robust policy evaluations.


**Figure 6.2** Responses to the question 'What communication channels would be helpful for facilitation collaborations in the future?'. Workshop conducted at the ECDHM in September 2023 in Vienna, Austria.

## 6.4 Strengths and limitations

Each of the empirical chapters has its own set of strengths and limitations, which are discussed within the chapters. Here, I discuss strengths and limitations of the overall thesis.

A strength of this thesis is its multidisciplinary approach that combines insights from different theoretical backgrounds and research traditions (experimental, observational, theoretical) and disciplines (economics, psychology, sociology), which provides a more comprehensive perspective on the topic. In addition, the integration of perspectives on the meso level and micro level influences on cooperation show the importance of both perspectives, and I have aimed to maintain the benefits of both approaches: the clear and causal evidence for the importance on social mechanisms from the experimental literature, and the focus on practical relevance and the individual decision-making process from the individual-centred blood donation literature. I have done so by drawing on large sets of register and survey data and by using a variety of statistical methods suited to my goals. Where necessary, I provide causal evidence, and I avoid causal statements where these are not justified based on my analyses. In its focus on embedding micro-level theories of blood donation behaviour in the meso-level social interactive context, this thesis makes an important addition to the sociological perspective on blood donation behaviour.

Another strength of this thesis is the study of real world prosocial behaviour in the form of blood donation. This results in a higher practical relevance and higher applicability of findings as compared to laboratory experiments. As discussed in the previous section, this thesis has generated several insights that can be used by blood collection agencies to improve recruitment and particularly retention strategies. In all of the empirical chapters of the thesis, I was able to highlight practical recommendations for the blood donation context in which I conducted the study.

Finally, a strength of the research is the transparency of the research process through following open science research practices. For example, all chapters that conduct confirmatory research have been preregistered, and code has been made publicly available to increase the transparency and reproducibility of the research. Unfortunately, research data underlying the chapters using data from the Netherlands could not be shared publicly, which reduces reusability and reproducibility of these chapters. The data underlying Chapter 5 will be made publicly available after publication of the article in a scientific journal. Supplementary materials (e.g., preregistrations, code) for all chapters are openly available on the OSF at: https://osf.io/476jm/.

A limitation of this thesis arising from the focus on sustained cooperation and donor retention is the limited attention to non-donors and donor recruitment. Donor retention is certainly important from the perspectives of blood banks, and an interesting outcome for understanding sustained cooperation. However, there is a similar need for learning about why people decide to cooperate in the first place and the ways to potentially improve donor recruitment and to maintain a sufficiently large and diverse pool of donors (see e.g. Martín-Santana et al. (2020)).

A related limitation arising from the analysis of survey data in samples of existing donors is that most existing donors have relatively favourable attitudes towards blood donation behaviour. This means that changes in these attitudes over time are likely less common, smaller, and therefore harder to detect empirically. The formation and change of attitudes through social learning might be more likely to occur through childhood and adolescence, for example through familial influences (Bandura 1977; Hughes et al. 2018; Quéniart 2013). A general limitation of chapters drawing on survey data is non-response bias. However, an in-depth analysis of the DIS study suggests that the original sample was representative of the donor population in terms of age, body mass index, haemoglobin level, blood pressure, blood type and donation behaviour (Timmer et al. 2019). Another limitation of the DIS survey is that some of the psychological measures had not been validated before the inclusion in the survey, and that some of the constructs therefore have low internal reliability.

Another limitation is the low geographical coverage of the empirical studies conducted in this thesis. There are large variations in human behaviour across societies even in laboratory experiments (Henrich et al. 2001; Henrich et al. 2010), and donor retention and

recruitment practices will likely similarly depend on general cultural differences across countries (Graf et al. 2023). Accordingly, we should expect to find differences in the effectiveness of the proposed interventions due to cultural and institutional differences and due to variations in collection regimes. This means that the applicability of my findings remains limited to the context of the Netherlands and Australia, and potentially culturally similar countries with similar VNR blood donation systems. While many countries' collection regimes can be classified as VNR blood donation systems, there is a large variety in donation systems within this category and even more variation in the whole spectrum of blood collection regimes, and we cannot expect the findings to generalise to these settings.

Another limitation is that I am largely unable to identify specific social relationships that are important for social influences on blood donation behaviour, and to track the co-evolution of social networks and blood donation behaviour over time. Chapters 3 and 5 show that partners are important, and that groups that are formed along existing social relations, for example among colleagues, family and friends, impact blood donation behaviour. Beyond these findings, however, I was not able to pinpoint the nodes within a social network that are ultimately responsible for the social mechanisms that I study.

Finally, a limitation of this this thesis is that it is not immediately clear how the findings generated through the analysis of blood donation, and specifically those on group formation from Chapter 5, would translate back to the large body of research conducted in the laboratory. Even though there are several key similarities between VNR blood donation systems and social preference games, I have also shown that there are several clear differences. These differences present an interesting opportunity for future research, where findings from the field could be taken back to adapted social preference games that more closely resemble some of the social dilemmas that exist in the real world to strengthen both the external validity of social preference games and the grip on causal effects underlying the findings of this thesis.

## 6.5 Future research

The research conducted throughout this thesis has generated many directions and open questions for future research, which I briefly discuss below.

In Chapter 5, I have shown that a group membership programme can be highly effective for increasing donation frequency. An interesting question for future research would be to what extent a group membership programme might be effective for the recruitment of new donors. Because of constant lapse of donors for many reasons and the upper limit to donation frequency imposed by health considerations (Van Remoortel et al. 2023), there is a constant need to recruit new donors. Sun et al. (2019) have previously shown that donors can be motivated to use their social networks for the recruitment of new donors by provid-

ing group rewards, that is, rewards for both the new and existing donor. Similarly, a recent study conducting a detailed investigation of one team participating in the Lifeblood Teams programme found that competition between teams and peer-led engagement contributed to increased recruitment rates to this team (Bryant et al. 2023). Offering such incentives within the context of a group donation programme could lead to an effective programme for both recruitment and retention of blood donors.

Another avenue for future research arising from Chapter 5 is to disentangle the effect of group size on cooperation from the effect of giving to a club good (where benefits are only shared within the group) versus giving to a public good (where benfits are shared among the whole population). A large body of experimental studies has worked on the question how cooperation in public goods games is affected by the size of the group, but the debate seems not yet settled (Isaac and Walker 1988; Pereda et al. 2019; Zelmer 2003). In addition, recent work has shown that cooperation poses an additional challenge when benefits are shared with a bigger collective rather than just within the own group (Gross et al. 2023). Both of these factors similarly affect the MPCR, such that increasing group size and giving to a public good would reduce the individual benefit. However, they may not necessarily affect contributions in the same way, for example because of varying preferences for giving to members of the ingroup vs. the outgroup (Balliet et al. 2014).

Further research could also be conducted with regards to the psychological mechanisms underlying the effects of conditional cooperation and group formation. In the analysis of the mechanism of conditional cooperation in Chapter 3, I was not able to show that any of the constructs hypothesised to capture normative and informational social influences explain conditional cooperation. However, knowing about these mechanisms could improve our theoretical understanding and show in which situations and for which individuals conditional cooperation may be at work. In Chapter 5, I similarly discussed that there are many potential mechanisms that might explain the effectiveness of group membership for increasing contributions to a public good. Among them are shared identity, intergroup competition, a reminder function, reduced coordination effort, and reduced uncertainty about others' behaviour, all of which likely contribute to its effectiveness. To examine these mechanisms, a promising direction for future research would be to conduct a field experiment that varies specific aspects of a group-membership programme, such as the emphasis on a common identity, intergroup competition, or clear information about others behaviour.

Another avenue for future research could be to clearly disentangle within- and between-person effects of the TPB constructs on blood donation behaviour, i.e. to what extent the level of these constructs is predictive of differences in donation behaviour between people or to what extent changes in these constructs are associated with changes in behaviour over time. While the necessary methodological tools to differentiate between the two have been available for a long time, much of the research on blood and plasma donation behaviour has so far been based on cross-sectional data or focussed on one of these questions.

Differentiating between the two effects within a single data set and across the donor career could provide a crucial understanding of the difference between who is more likely to be a blood donor or a very loyal donor versus how to understand behaviour change.

In Chapter 2, I have shown that it is important to consider heterogeneity in donor motivations at one point in time as well as the changes in donor motivation over time. An important extension of this research would be to also collect information on non-donors, and to track the heterogeneity of motivations before (potentially) becoming a donor, which may explain why some people becoming a blood donor, and to then track the development of these motivations over the course of the donor career while considering heterogeneity in these motivations.

Another promising extension of the research conducted in this thesis would be the analysis of how donation behaviour and social networks co-evolve using longitudinal social network data. Social networks are the channels through which social mechanisms operate, and they are themselves the outcomes of social processes (Simpson and Willer 2015). Thus, future analyses could analyse how blood donation behaviour develops over time, while explicitly taking the dynamic development of social networks into account. Such research could answer questions such as: Which characteristics of nodes in social networks (e.g. their position in networks) facilitate the spread of blood and plasma donation behaviour? Through which types of relations (e.g. family ties, or relationships at work or through schools) does blood and plasma donation behaviour spread? Can social network structure explain spatial clustering in blood and plasma donation behaviour?

Another avenue for research would be to examine to what extent the findings of this thesis, especially on the effectiveness of group formation, translate to other domains of prosocial behaviour, and to what extent they can be relevant for the practice of organisations operating in the field of charitable giving and volunteering. While there is some initial evidence for the effectiveness of group formation in the field of charitable giving (Eikenberry et al. 2009) and prosocial lending (Ai et al. 2016; Chen et al. 2017), knowledge about its effectiveness is still limited. One of the dimensions in which blood donation, charitable giving and volunteering may differ is the extent of (in-person) interaction between contributors and thus the channels along which social influences may operate. The types of interactions with others are central for the social mechanisms of conditional cooperation, communication, and group formation that I have analysed throughout this thesis. For example, blood donation might be particularly suited for a group-membership programme to work because it facilitates in-person interaction. However, the suggested mechanisms through which joining a group of other donors increases contributions (e.g., conditional cooperation, group identification) may also work through other channels. If the potential for in-person interactions between contributors is lower, it might also be useful to make use of social information, which explicitly highlights the giving behaviour of others, can be effective to increase charitable donations, and can be used via many channels (van Te-

unenbroek et al. 2020). Another dimension that may be relevant for social influences is the probability of interaction between donors and recipients. For example, while blood donors will essentially never interact with the recipients of their donations, this is more likely to be the case with charitable giving, and even highly probable for many types of volunteering. As Ferguson (2015) has shown, additional social mechanisms that require interactions between donors and recipients have been identified in the experimental literature on cooperation. Future research could study these mechanisms in the case of charitable giving and volunteering.

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# Summary

Cooperation — a behaviour that benefits a group, potentially including the self — is indispensable for the provision of many public goods. Voluntary and non-remunerated blood donations exemplify such cooperation, where individuals make costly contributions to a public good. These donations, while individually costly in terms of time and potential inconveniences, enable many routine medical treatments and the production of plasma-derived medicinal products.

A key challenge in research on cooperation is identifying how to sustain this behaviour over time. While theoretical studies and laboratory experiments have shown that social mechanisms are vital for enabling sustained cooperation, it remained unclear to what extent these mechanisms can explain and promote cooperation in the real world. This thesis addressed this gap in the literature by empirically studying how motivational diversity, social contagion, communication, and group formation shape blood donation behaviour.

The general introduction (Chapter 1) motivated the topic by briefly reviewing two central strands of the literature: the largely individual-centred literature on blood donation behaviour, and the experimental literature on social mechanisms that sustain cooperation. It presented a conceptual model that illustrates the human decision-making process about blood donation on the individual level, and emphasises the importance of social networks and relations, where individuals are exposed to social influences and where the studied social mechanisms operate.

Chapter 2 synthesised previous individual-centred literature on motivational determinants of repeated blood donation behaviour. The study used mixture modelling to develop a tangible classification of blood donors that is both theoretically informative and that may be used by blood collection organisations aiming to tailor their retention strategies to specific groups of donors. We identified four distinct types of donors that vary in their motivations, socio-demographic characteristics, and long-term donor lapse. In addition, we found that donors often transition between these types over time. Extending previous theoretical models of repeated blood donation behaviour, this chapter showed that to understand donor retention, we should consider both cross-sectional and longitudinal heterogeneity in blood donor motivations. Relevant for blood banking practice, it showed that self-efficacy and

habit formation are particularly important characteristics of donors that are more likely to be retained for a long time.

Chapter 3 analysed to what extent social contagion within neighbourhoods, defined as changing behaviour in response to the behaviour of others, affects repeated blood donation behaviour. The results showed that blood donors behave in a conditionally cooperative way: they increase or decrease their donation frequency in line with increases or decreases in the donation frequency of others, particularly their partners. We did not find evidence that this social contagion works through normative social influence — an influence to conform with the positive expectations of another — or informational social influence — accepting information obtained from another as evidence about reality. The results of this chapter imply that social contagion should be considered as an additional relevant explanatory factor in theories of real-world cooperation. For blood banking practice, our results imply that retention efforts are likely to be more successful when targeted at groups of donors.

Chapter 4 studied how recruitment via word of mouth (WOM) and talking about donations at both the individual and collection-site level relate to compliance with solicitations for donations by the Dutch blood bank. We found that individual-level talking about donations predicts compliance with solicitations for donations, and that this association is moderated by donor experience, such that it is strongest for novice donors with few previous donations. In addition, we found that donors recruited via WOM have similar compliance rates to donors recruited via traditional channels (brochures, newspapers, or internet). The primary contributions of our study to theory are to conceptualise solicitations for donations as a distinct level of analysis, and to demonstrate the social embedding of the donors' decision-making processes about compliance with such solicitations. For practice, our results imply that to increase compliance with solicitations for donations, blood banks could make use of strategies aimed at increasing communication about blood donation among their donors and novice donors in particular.

Chapter 5 evaluated an intervention set up to make use of social mechanisms, such as those identified in the previous chapters: a nationwide group membership programme for blood donors in Australia. Drawing on data for the entire population of blood and plasma donors in Australia between 2016 and 2019, we provided quasi-experimental estimates for the effect of joining a blood donor group on donation frequency. The results showed that the strategy is highly effective. We further analysed heterogeneity in the effectiveness of the programme, and potential barriers to its long-term sustainability. Contributing to the multidisciplinary literature on cooperation, this study showed that the strategy of group formation among contributors works to increase cooperation in the real world, at societal scale, and even for the case of the repeated high-cost prosocial behaviour of blood donations. Contributing to practice, our results showed that offering a group-membership programme can be very effective, but also that there is a need for a close monitoring of its long-term effectiveness and sustainability in terms of donor health.

The general discussion (Chapter 6) critically evaluated the research that has been conducted in the empirical chapters and points out areas for future research. In addition, it reported on current challenges for collaboration between researchers and blood banking practitioners based on a workshop conducted with researchers and practitioners in the field, and makes suggestions on how to tackle these challenges to achieve mutual learning. Finally, it highlighted the main contribution of this thesis in linking the largely individual-centred blood donation literature with the experimental literature on social mechanisms that sustain cooperation, and to empirically demonstrate the benefits of this perspective for understanding cooperation, blood donation behaviour, and blood banking practice.

# Samenvatting

Samenwerking is onontbeerlijk voor de beschikbaarheid van veel publieke voorzieningen. Vrijwillige en onbetaalde bloeddonaties zijn een ideaaltypisch voorbeeld van samenwerking, waarbij individuele donoren een kostbare bijdrage leveren aan een publieke voorziening. Door donaties die voor de donor kostbaar zijn wat betreft tijd en mogelijke ongemakken, maken bloeddonoren veel standaard medische behandelingen mogelijk (bijv. de transfusie van patiënten na een ongeval of met brandwonden) en zorgen ze dat er van plasma geneesmiddelen kunnen worden gemaakt.

Een grote uitdaging in onderzoek naar samenwerking is om vast te stellen hoe dit gedrag in stand gehouden kan worden in de loop der tijd. Hoewel in theoretische onderzoeken en laboratoriumexperimenten is vastgesteld dat sociale mechanismen een sleutelrol spelen in het mogelijk maken van langdurige samenwerking, is het grotendeels onduidelijk in welke mate deze mechanismen in het echte leven samenwerking kunnen verklaren en bevorderen. In dit proefschrift wordt deze kloof in de literatuur overbrugd door empirisch te onderzoeken hoe variatie in motivaties, sociale besmetting, communicatie en groepsvorming bloeddonatiegedrag beïnvloeden.

In de algemene inleiding (hoofdstuk 1) worden twee hoofdstromen in de literatuur besproken: de grotendeels op het individu gerichte literatuur over bloeddonatiegedrag en de experimentele literatuur over sociale mechanismen die samenwerking in stand houden. Er wordt een conceptueel model gepresenteerd dat het individueel besluitvormingsproces rondom bloeddonatie illustreert. Daarnaast benadrukt het model het belang van sociale netwerken en sociale relaties waarin individuen blootgesteld worden aan sociale invloeden en waar de sociale mechanismen die worden onderzocht plaatsvinden.

In hoofdstuk 2 wordt eerdere op het individu gerichte literatuur over motivaties van herhaald bloeddonatiegedrag gesynthetiseerd door de heterogeniteit in motivatie van bloeddonoren te onderzoeken. In het onderzoek werd een concrete classificatie van bloeddonoren ontwikkeld die theoretisch informatief is maar ook kan worden gebruikt door organisaties die bloed inzamelen om hun strategieën voor donorbehoud af te stemmen op specifieke groepen donoren. Er zijn vier afzonderlijke types donoren gevonden die verschillen in hun motivatie, sociaal-demografische kenmerken en in op welke termijn ze stoppen met

doneren. Daarnaast werd gezien dat donoren in de loop der tijd vaak van het ene in het andere type veranderen. In het verlengde van eerdere theoretische modellen over herhaald bloeddonatiegedrag, toonde dit hoofdstuk aan dat het nodig is om zowel rekening te houden met cross-sectionele als met longitudinale heterogeniteit in de motivaties van bloeddonoren voor beter inzicht in het behoud van donoren. Voor bloedbanken is belangrijk om te weten dat met name self-efficacy en gewoontevorming belangrijke kenmerken zijn van donoren die langere tijd behouden kunnen worden.r

In hoofdstuk 3 wordt geanalyseerd in welke mate sociale besmetting, gedefinieerd als gedragsverandering als reactie op het gedrag van anderen, van invloed is op herhaald bloeddonatiegedrag. Uit de resultaten bleek dat bloeddonoren zich op een voorwaardelijk coöperatieve manier gedragen: ze verhogen of verlagen hun frequentie van donaties in overeenstemming met de verhoging of verlaging van de donatiefrequentie van anderen en dan in het bijzonder die van hun partners. Verder is er geen bewijs gevonden dat deze sociale besmetting werkt door normatieve sociale invloed (een invloed om te voldoen aan de positieve verwachtingen van iemand anders) of informationele sociale invloed (aanvaarden van informatie die van iemand anders wordt verkregen als bewijs voor de realiteit). De resultaten van dit hoofdstuk impliceren dat sociale besmetting moet worden beschouwd als een aanvullende relevante verklarende factor in theorieën over samenwerking in de echte wereld. Voor bloedbanken impliceren deze resultaten dat donorbehoud gericht op groepen van donoren een grotere slagingskans heeft.

In hoofdstuk 4 wordt bekeken hoe werving via mond-tot-mondreclame en praten over donaties, zowel op individueel niveau als op inzamellocaties, verband houden met het gehoor geven aan oproepen voor bloeddonaties van de Nederlandse bloedbank. Het bleek dat praten over donaties op individueel niveau een voorspeller is voor het gehoor geven aan een oproep, afhankelijk van de ervaringen van de donor. Het verband is het sterkst voor nieuwe donoren die nog niet vaak bloed hebben gegeven. Daarnaast werd duidelijk dat donoren die zijn geworven via mond-tot-mondreclame net zo vaak positief reageren op verzoeken als donoren die zijn geworven via traditionele kanalen (brochures, kranten of internet). Voor de praktijk betekenen deze resultaten dat bloedbanken gebruik kunnen maken van strategieën die gericht zijn op het verhogen van communicatie over bloeddonatie onder hun donoren en in het bijzonder onder nieuwe donoren.

In hoofdstuk 5 wordt een interventie geëvalueerd die gebruik maakt van sociale mechanismen: een landelijk groepsprogramma voor bloeddonoren in Australië. Er worden quasi-experimentele schattingen gegeven voor het effect van het aansluiten bij een bloeddonorgroep op de donatiefrequentie. Uit de resultaten bleek dat de aanpak zeer effectief is, met een toename in donatiefrequentie van ongeveer 37% in de loop van drie jaar na dat een donor zich bij een groep aansluit. Verder werd heterogeniteit in de effectiviteit van het programma geanalyseerd evenals mogelijke obstakels voor de duurzaamheid op lange termijn. Dit onderzoek draagt bij aan aan de multidisciplinaire literatuur over samen-

werking, toonde aan dat de strategie van groepsvorming onder donoren werkt voor het vergroten van samenwerking in de echte wereld, op maatschappelijke schaal, en zelfs in het geval van herhaalde bloeddonaties. Voor de praktijk is gebleken dat het aanbieden van een programma van groepslidmaatschap zeer effectief kan zijn, maar ook dat er een noodzaak bestaat om de effectiviteit op lange termijn en de duurzaamheid wat betreft de gezondheid van de donor goed in de gaten te houden.

De algemene discussie (hoofdstuk 6) biedt een kritische evaluatie van het onderzoek dat in de empirische hoofdstukken is uitgevoerd en geeft aan op welke gebieden nog onderzoek nodig is in de toekomst. Daarnaast wordt hier verslag gedaan van de huidige uitdagingen voor samenwerking tussen onderzoekers en medewerkers van bloedbanken op basis van een workshop die is gehouden met onderzoekers en medewerkers in de praktijk en hoe mogelijk kan worden omgegaan met deze uitdagingen om wederzijds leren te faciliteren. Ten slotte wordt de belangrijkste bijdrage van dit proefschrift onderstreept, namelijk het slaan van een brug tussen de grotendeels op het individu gerichte literatuur over bloeddonatie en de experimentele literatuur over sociale mechanismen die samenwerking in stand houden en het empirisch aantonen van de voordelen van dit perspectief voor inzicht in samenwerking, bloeddonatiegedrag en de praktijk van bloedbanken.

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