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The role of closeness in the relationship between nonverbal mimicry and cooperation

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Declaration

I declare that the work presented in this thesis is, to the best of my knowledge and belief, original and my own work. The material has not been submitted, either in whole or in part, for a degree at this, or any other university. This thesis does not exceed the maximum permitted word length of 80,000 words including appendices and footnotes but excluding the bibliography. A rough estimate of the word count is: 44,300

Abbie Jean Maroño

I dedicate this thesis to my father, for continuing to fight against the odds. You keep me strong; I love you.

Abstract

The 'social glue' function of nonverbal mimicry has received much support in the empirical literature, with research demonstrating its prosocial consequences, including increased cooperation. When looking to explain why nonverbal mimicry effects behaviour, some research has pointed to interpersonal closeness. However, in these studies, a robust measurement of nonverbal mimicry and closeness is absent, making it impossible to confidently argue that the observed mimicry resulted from increased closeness and not a third factor. Likewise, without a reliable measure of nonverbal mimicry it is not possible to determine that nonverbal mimicry was manipulated sufficiently. This thesis addresses this by testing the impact of nonverbal mimicry on cooperation through closeness, using rigorous measures. In chapter 3 I use high-resolution motion tracking—Xsens MVN systems—to demonstrate that an increased closeness towards a partner is associated with more nonverbal mimicry of that partner. It also identified regions of mimicry (discreet body movements) that are related to closeness. Chapter 4 showed a positive relationship between nonverbal mimicry and closeness but found no mediation effect of closeness on the relationship between mimicry and cooperation. In chapter 5, I controlled for methodological limitations in Chapter 4 and found a positive relationship between nonverbal mimicry and cooperation and supported a mediating effect of closeness. Extending beyond mimicry within the dyad, chapter 6 showed that third-party observers would be more willing to engage in conversation with dyads who showed increased nonverbal mimicry compared to lower amounts of nonverbal mimicry. The effects of third-party nonverbal mimicry were mediated by closeness towards the dyad. Overall, this thesis provides robust evidence for closeness as one of the psychological mechanisms underpinning how nonverbal mimicry works to increase cooperation and provides new insight into the relationship between nonverbal mimicry and social judgements.

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CHAPTER ONE: GENERAL INTRODUCTION

Information obtained from suspects and/or witnesses play a crucial role in the crime solving process (Collins & Carthy, 2019; FBI 2018). As such, when a suspect or witness is apprehended there is an urgent need for investigators to elicit intelligence successfully and reliably (Goodman-Delahunty & Martschuk, 2020; Granhag, Kleinman, & Oleszewicz, 2016). The two main approaches to elicit information during investigative interviews are Accusatory approaches and Information gathering approaches. Accusatory approaches are based on the presumption of guilt and aim to extract a confession. Such approaches use psychological manipulation and aim to establish control over the suspect, using tactics such as closed-ended questions designed to confirm what the interrogator believes to be true (Kassin et al., 2010; Kelly & Meissner, 2015). The use of accusatorial methods has been shown to significantly increase the likelihood of a false confession (Bull & Milne, 2004; Kassin et al., 2010; Keatley, Marono, & Clarke, 2018). In contrast to the accusatory approach is the information gathering interviewing approach (Meissner et al., 2014). The information gathering approach is based on developing rapport, or a "working alliance", with the interviewee and eliciting information to learn the truth rather than eliciting a confession (Walsh, Oxburgh, Redlich, & Myklebust, 2016). Information gathering approaches are evidenced to be more effective at influencing true confessions and minimising false confessions compared to accusatorial approaches (Evans et al., 2013; Granhag, 2010; Vanderhallen & Vervaeke, 2014). The key principle underpinning the success of Information gathering approaches is the ability to open the lines of communication between suspect and investigator and influence cooperation (Brimbal, Dianiska, Swanner, & Meissner, 2019). Information disclosure is a particularly important form of cooperation in this context (Perry & Hasisi, 2020). Without cooperation from interviewees, misunderstandings, and

miscommunications between interactants are common, reducing the ability of law enforcement officials to respond effectively to crimes (Granhag, Kleinman, & Oleszkiewicz, 2016; Myhill & Quinton, 2011). The current thesis demonstrates that nonverbal mimicry is an effective cooperation enhancing mechanism and increases information disclosure of a source, thus suggesting that information gathering approaches may benefit from the inclusion of nonverbal mimicry.

1.1 Nonverbal mimicry and cooperation

Nonverbal mimicry can be broadly defined as the tendency to imitate an individual with whom we are interacting (Hess, Philippot, & Blairy, 1999). Mimicry is an umbrella term which includes facial mimicry (also referred to as emotional mimicry (Hess & Bourgeois, 2010)) behavioural mimicry (Tschacher, Rees, & Ramseyer, 2014), and verbal mimicry (Sun, Truong, Pantic, & Nijholt, 2011). The focus of the present thesis, however, is behavioural mimicry which we will refer to throughout as nonverbal mimicry (NVM). NVM refers to when a person imitates the nonverbal behaviour of a conversational partner while they interact (Genschow et al., 2018; Chartrand & Van Baaren, 2009). This mimicry typically occurs without conscious awareness (Bavelas, Black, Lemery, & Mullett, 1986; Chartrand & Bargh, 1999), such that if person A is standing with their hand on their hip, person B may then adopt this same posture without realising that they are mimicking. From an evolutionary perspective, Lakin, Jefferis, Cheng, and Chartrand (2003) argue that nonverbal mimicry originally had a survival value of helping humans communicate. Our ancestors used their nonverbal behaviours to communicate necessary survival information to one another, and the perceptions of others' behaviours were used to guide one's own behaviour (Chartrand, Maddux, & Lakin, 2005). Hence, the ability to perceive other's behaviours not only enabled us to analyse the world around us, but also told us how we needed to behave in order to

survive (Dijksterhuis & Bargh, 2001; Milner & Goodale, 1995). This is known as the perception-behaviour link, or 'monkey-see-monkey-do' learning (Chartrand, Maddux, & Lakin, 2005). NVM is argued to have been a manifestation of the perception–behaviour link, with those who possessed these automatic mimicking tendencies were more likely to survive as a result of natural selection. As our ecological world developed, so did the social world, communal living and social dependence became more important and those who were unable to form group relationships were less likely to survive and successfully reproduce (Buss & Kenrick, 1998; Johanson, Johanson & Edgar, 1996). Thus, there became less selection pressure on behaviours that communicated survival information and more pressure on "social survival" and behaviours that fostered group cohesion (Lakin, & Chartrand, 2003). As a result, although automatic mimicry remained an adaptive behaviour, its function shifted from communication to social bonding. In other words, mimicry has ultimately evolved to serve a "social glue" function, through its adaptive ability to help bind people together and facilitate harmonious interpersonal interactions (Hale & Antonia, 2016; Lakin, & Chartrand, 2003; van Baaren, Holland, Kawakami, & van Knippenberg, 2004).

Evidence in support of the evolved function of mimicry can be found in studies that show increased levels of nonverbal mimicry in individuals who have an explicit goal to affiliate with their interaction partner (Hove & Risen, 2009; Lakin, Chartrand, & Arkin, 2008). For instance, in a study by Lakin and Chartrand (2003) half of the participants involved were subliminally primed with an affiliation goal and half were not. Participants then interacted with a confederate and were led to believe they had been successful or unsuccessful in their attempt to affiliate. Following this, participants interacted with a second confederate who tapped their foot throughout the interaction. Results showed that when there was no initial goal to affiliate, participants were equally as likely to mimic the foot tapping of the confederate, however, when given an affiliation goal condition, participants were

significantly more likely mimic the foot tapping of the confederate if they had been unsuccessful in their attempt to affiliate compared to if they had been successful. Likewise, individuals who are single are more likely to mimic the behaviours of a confederate than participants who are in a committed romantic relationship (Karremans & Verwijmeren, 2008). Moreover, a study of speed dating showed that women who engaged in NVM received greater interest from their male interaction partners, compared to women who did not engage in NVM (Guegen, 2009). In contrast, individuals who report a lack of interest in their relationship partner exhibit less NVM, this is particularly the case when meeting for the first time (Chartrand et al., 2005). Thus, it is evident that mimicry has adaptive functions to strengthen social bonds and foster relationships with others by influencing affiliation in interactions (Bailenson & Yee, 2005; Bernieri, 1988; Kulesza & Kot, 2016; Kouzakova, Kouzakova, van Baaren, & van Knippenberg, 2010; La France & Broadbent, 1976).

The ostracism and social exclusion literature provide further evidence for the evolved social-glue function of nonverbal mimicry (Caporael, 1997, 2001; Lewin, 1993; Poirier & McKee, 1999). Researchers in the ostracism and social exclusion literature have stressed the importance of belonging and argue that a sense of belonging shields us from the devastating social, psychological, and behavioural consequences of social exclusion (Baumeister & Leary, 1995; Leary, 2001; Leary & Baumeister, 2000). This need to belong can be achieved through NVM as it helps foster relationship formation and affiliation (Guéguen, Jacob, & Martin, 2009). Indeed, research has shown that the need to belong triggers mimicry behaviours and observed increased NVM in those who risk social exclusion (Lakin, Chartrand, & Arkin, 2008). Likewise, Lakin et al. (2008) showed that mimicry was used as a tool by participants to regain their status within an ingroup after being rejected by them. Furthermore, if mimicry serves to foster harmonious relationships, this may explain why

mimicry has also been shown to increase pro-social behaviour. Social relationships can be built and strengthened through helping behaviour (Burger, Messain, del Prado & Anderson, 2004). For example, Van Baaren, Holland, Kawakami, and Van Knippenberg (2004) found that participants were more likely to help a confederate who had "accidentally" dropped some pens on the floor if the confederate had engaged in NVM during the experiment than if the confederate had not. Maddux, Mullen, and Galinsky (2008) found that confederates who mimicked the nonverbal behaviours of participants obtained better outcomes in negotiations compared to those who did not mimic the participants. Similarly, participants were more likely to adhere to a virtual agent's message about a campus security policy if the virtual agent had mimicked the participant's head movements (Bailenson & Yee, 2005). Guéguen, Martin, and Meineri (2011) showed that participants were significantly more likely to agree to give a confederate written feedback on an essay if the confederate had engaged in NVM during a prior interaction. Thus, considering that nonverbal mimicry increases the desire to affiliate and positively influences helping behaviour, this dual effect supports the function of NVM as a cooperation-enhancing mechanism (Haidt et al., 2008; McNeill, 1995; Shaw et al., 2015).

1.2 Processes of mimicry

When looking to understand the why mimicry affects affiliation, many researchers have focused on the importance of similarity (Choi, Kornfield, Takayama, & Mutlu, 2017; Guéguen, Jacob, & Martin, 2009; Van Swol & Drury-Grogan, 2017). For example, early experiments suggested that confederates who engaged in NVM were rated by participants as more similar compared to confederates who did not engage in NVM (Dabbs Jr., 1969; Navarre, 1982). LaFrance (1982) argued that shared viewpoints between individuals resulted in increased NVM. Van Swol and Drury (2008) found that participants mimicked confederates more when confederates expressed the same viewpoint as them, compared to

confederates who expressed disagreement. Guéguen and Martin (2009) showed that participants mimicked the nonverbal behaviours of an individual shown on a video when they were led to believe they were similar to one another. However, a direct link between similarity and NVM has not been consistently replicated (Van Swol, 2003). Other researchers have even argued that perceived attribute dissimilarity among romantic partners leads to more positive social consequences, such as increased liking and attraction, compared to perceived similarity (Amodio & Showers, 2005; Aron et al., 2006; Sprecher et al., 2015).

Alternatively, several researchers have suggested a direct link between mimicry and liking (Bernieri, 1988; Charney, 1966; LaFrance, 1979; Van Baaren, Holland, Kawakami, & Van Knippenberg, 2004). Chartrand and Bargh (1999) found that confederates who mimicked participants were rated by participants as more likable than those who did not engage in mimicry. Moreover, dislike of a person has been shown to decrease NVM (Stel, van Baaren, Blascovich, et al. 2008), and prior liking is also associated with elevated NVM (Stel, van Baaren, Blascovich, et al. 2008), suggesting a possible bi-directional relationship between NVM and liking (Stel et al., 2010). However, much like the research concerning similarity, the effects of liking are inconsistent across the literature. In a study by Verberne et al. (2013), participants engaged in two behavioural trust games, an investment game and a route planner game, with a virtual agent. The virtual agents either mimicked or did not mimic the participant. Findings indicated that mimicry led to liking for the investment game, but not the route planner game.

Hale (2017) conducted a meta-analysis of twelve studies examining the relationship between liking and NVM. Of the twelve studies, six supported a positive association between liking and mimicry, but the other six found no significant effect. What is more, the studies that did find a positive effect were limited by small effect sizes (eta-squared close to 0.1). Other work has argued that the helping behaviours observed following NVM may be due to

enhanced familiarity. For example, Guéguen, Jacob, and Boulbry (2007) found that customers were more likely to comply with a seller's suggestion if the seller engaged in NVM, and that customers in the mimicry condition reported increased familiarity with the seller than those in the non-mimicry condition. However, the author did not account for familiarity being associated with an increased desire to affiliate, as shown in previous research (Shimpi, Akhtar, & Moore, 2013; Wikberg, Ting, & Sicotte, 2014) rather than directly related to increased NVM. Additionally, the role of familiarity does not appear to be supported in any further empirical work.

Evidently, the precise mechanism through which NVM influences positive social consequences remains a matter of debate. This thesis draws on recent research examining facial mimicry for new insight into the processes involved (Au & Lo, 2020; Cooke et al., 2018; Peng, Zhang, & Hu, 2021). This research has provided strong evidence that interpersonal closeness, conceptualised as self–other overlap, mediates the social consequences of facial mimicry (Au & Lo, 2020; Cooke et al., 2018; Peng, Zhang, & Hu, 2021). Of course, facial mimicry and behavioural mimicry are distinct, though possible related, behaviours (Hess & Fischer, 2014; Prochazkova & Kret, 2017). NVM involves the imitation of potentially emotion neutral behaviours, while facial mimicry often involves the imitation of the emotional expressions (Hatfield, Cacioppo, & Rapson 1992). Yet, although examining the relationship between facial mimicry and NVM is beyond the scope of the thesis, a similar relationship between closeness and NVM is evident in the NVM literature (Ashton–James, Van Baaren, Chartrand, Decety, & Karremans, 2007; Gueguen, Jacob, & Martin, 2009; Van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009; Van Swol, & Drury-Grogan, 2017). In the following section, then, I review closeness as one of the psychological process that mediates the effects of NVM.

1.3 Interpersonal closeness

What interpersonal closeness is conceptualised as is a historical debate, with researchers arguing for the inclusion of terms such as love, trust, commitment, caring, stability, attachment and one-ness (Clark & Reis, 1988; Mashek & Aron, 2004; Maxwell, 1985; Snyder, Berscheid, & Glick, 1985). Closeness is most often confused as synonymous with intimacy (Mashek & Aron, 2004; Parks & Floyd, 1996). Although closeness and intimacy may be near synonymous when referring to committed romantic relationships (Sternberg, 1988), such is not the case with other social relationships. For example, strangers, friends, cousins, and colleagues would not be considered intimate but all differ in degrees of closeness (Parks & Floyd, 1996). Major advancements in the conceptualization of closeness followed Kelley et al.'s (1983) publication of "Close relationships". According to Kelley et al. (1983), a close relationship is defined as a relationship in which both individual's behaviours, emotions, and thoughts are mutually dependant. The degree of change in one because of the other indicates a high degree of interdependence. Kelley et al. (1983) emphasized the importance of strength, frequency, diversity, and duration in the conceptualisation of interdependence. The strength of influences refers to how much one partner influences the other partner's thoughts, feelings, and behaviours directly. Frequency of interaction indicates how much time both individuals spend together, those who spend more time together are more likely to have a greater impact on one another. Diversity is based on one having an impact on a range of different and diverse aspects and experiences of the other's life. For example, one partner influences the other's behaviours relating to the self, family, and education. Finally, duration refers to how long one has an influence on the other. Individuals who are interdependent for longer are expected to be closer than individuals who spend less time together.

The concept of interdependence as closeness takes into account that experiences of closeness are not limited to romantic relationships. Interdependence can be evident between peers, parent and child, student and teachers (Afifi & Schrodt, 2003; Aron, Aron, Tudor, & Nelson, 1991; Berscheid et al., 1989; Dibble, Levine, & Park, 2012). However, supporting research for the theory failed to stray far from a focus on dyadic adult heterosexual relationships, so findings from the development and change of interdependence are not generalizable beyond this sample (Miell & Duck, 1984). Additionally, the authors state that the strength, frequency, diversity, duration of interdependence is important for examining closeness, yet failed to define what parameters should be used to determine the degree of interdependence. For example, it is not clear what the measurable differences between a strong and a weak influence of the other and what constitutes as 'strong'. This lack of clear classification and examination into individual differences has led to much ambiguity in determining closeness (Aron & Fraley, 1999).

Finally, the conceptualisation of closeness as synonymous with interdependence has been criticised for its exclusion of sentiment, both for one another and for the relationship in general (Aron, Aron, & Smollan, 1992). Kelley et al. (1983) failed to explain how the positivity/negativity of sentiment and emotion in response to the others' behaviour effected interdependence. This led lay persons and researchers alike to conclude that increased interdependence should be characterised by increased positive sentiment and emotion towards each other and the relationship (Berscheid & Kelley, 2002). However, individuals who are highly interdependent do not necessarily feel positive sentiment and emotion towards one another. Take, for example, cases of domestic violence, often relationship partners are highly interdependent but experience extreme negative emotions towards one another (Keatley et al., 2021; Rook, 1984; Spitzberg & Cupach, 1998). Berscheid and Kelley (2002) recognised that culture may have played a role in the association between positive sentiment

and closeness. Individuals who come from a western, individualistic society may view relationship formation as a personal choice and conclude that one would only choose to form a romantic relationship with someone if they felt positive sentiment and emotions towards them. However, in some collectivist cultures, the formation and maintenance of a romantic relationship is involuntary and failure to interact with each other could be costly (Berscheid & Reis, 1998). Thus, although Kelley et al.'s (1983) conceptualisation of closeness as mutual dependence was largely influential in the field of human relationships (Dibble, Levine, & Park, 2012; Reindal, 1999), issues particularly concerning measurability and generalizability suggest the need for an alternative explanation.

Expanding on the concept of closeness as mutual dependence, Aron and Aron (1986) proposed the self-expansion model. Whereas Kelley et al. (1983) focused more on behavioural overlapping, Aron and colleagues emphasised overlapping cognitive structures of the self and close others. Aron et al. (1992) designed the Inclusion of Other in the Self Scale (IOS) as a single item pictural measure of closeness. The scale involves seven pairs of increasingly overlapping circles arranged from zero overlap (1, low degree of closeness) to almost completely overlapped (7, high degree of closeness), and respondents are asked to select the pair of circles that best represent their relationship with a target individual. This concept of closeness as feelings of overlapping selves has been present in the literature for decades, with Aron's self-expansion model becoming an influential and frequently used conceptualisation of closeness (Aron, Aron, Tudor & Nelson, 1991; Carpenter & Spottswood, 2013; Carson, Carson, Gil, & Baucom, 2007; Mattingly & Lewandowski, 2013; Reissman, Aron, & Bergen, 1993).

The central principle of the self-expansion model is that human beings are motivated to expand the self and seek to enhance their potential efficacy by increasing the resources and identities that assist in the achievement of goals. This notion is supported by models of

competence motivation, self-efficacy, and intrinsic motivation (See Bandura, 1977; Gecas, 1989; Ryan & Deci, 2000; White, 1959). Although one may take conscious steps towards obtaining a goal, the underlying motivation of self-expansion typically occurs without conscious awareness. One way in which people enhance their potential efficacy is through close relationships. That is, the self-expansion model argues that as one becomes close to their relationship partner, the cognitive representation of the other and the cognitive representation of the self become increasingly overlapping (Mashek & Aron, 2004). Thus, the inclusion of other in the self (IOS) is synonymous with relationship closeness (Weidler & Clark, 2011). As the other gets included into the self, so do their resources, perspectives, and identities (Aron & Aron, 1986; Aron, Aron, & Norman, 2001).

Resources in this context refers to material goods, knowledge, and social assets (i.e., networks, educational opportunities, etc.) that can help one achieve their goals. Including the other's resources in the self may be perceived as equivalent to those resources being one's own. Considering this, the motivational aspect of inclusion of the other in the self is clear, the outcomes of the other's behaviour are perceived as one's own. For example, if the other wins at a poker game one may feel as though they have won themselves. However, this is consistent with the loss of the other's resources, which may be perceived as losing one's own resources. Aron, Aron, Tudor, and Nelson (1991) demonstrated this effect in a study of monetary allocation decisions. Participants were given a monetary sum and were asked to decide how much they would like to keep for themselves and how much they would like to allocate to their partner. The partner was either a best friend or an acquaintance. It was made explicitly clear that the partner would have no way of knowing about their allocation decision or how much money was initially given. Findings demonstrated that participants equally distributed the money between them and their best friend but allocated themselves more money than acquaintances.

Social comparison researchers have shown that when closeness is created by a priming manipulation, one may experience the other's outcomes as their own (McFarland, Buehler, & MacKay, 2001; O'Mahen, Beach, & Tesser, 2000). Gardner, Gabriel, and Hochschild (2002) demonstrated that negative feelings were felt by a participant when their interaction partner outperformed them on a task. However, when primmed with feelings of closeness towards the other, the reduction of negative effects was correlated with the increased closeness. When IOS was high no negative feelings were reported, and participants instead celebrated their partner's win. Thus, this offers support for the notion that the other's benefits are perceived as one's own. Often the resources of a close relationship partner really are one's own, for example a shared home ownership, in other cases the resources of the other may not be shared even if one feels they have ownership over it. In cases such as the former, feelings of possession are likely to occur. Evidently, close relationships tend to be distinguished from other types of relationships through a sense of ownership over the relationship partner, shared identity, unison, proximity, and interconnectedness (Aron & Aron, 1986; Aron, Aron, & Norman, 2001, 2004).

The inclusion of the other's resources in the self is believed to be the motivation to include another in the self, whilst including the perspectives and identities of the other in the self is a side effect of the overlapping cognitive representations. Including the perspectives of the other in the self refers to experiencing the world from the other's point of view. For example, if one is taking on the perspective of the other, they are evaluating the world as the other would and are thus concerned for the other's outcomes. Thus, if the other is included in the self, one might take on the other's spiritual views, and self-related and cognitive biases. For example, when a close other is behaving socially inappropriately and acting somewhat embarrassing, one is likely to feel embarrassed as if the actions of the other were their own (Mashek & Aron, 2004). This may explain why individuals attempt to manage the

impressions others form about their close other, by presenting information about them that paints them in the best light, compared to presenting neutral information of non-close others (Schlenker & Britt, 2001).

Likewise, when recalling past successes and failures, recollection of events that happened to close others exhibit the same pattern of recollection as events that happened to the self; past successes were remembered as occurring more recently than they did and past failures were recalled as further away than they were (Konrath & Ross, 2003). This same pattern of recollection did not occur for previous relationship partners if the previous partner was not considered close. Brain imaging research using fMRI (Functional magnetic resonance imaging) has shown that the brain area involved in the personal experience of social exclusion (dorsal anterior cingulate cortex) is active when witnessing the exclusion of a close friend but not active when witnessing the exclusion of a stranger (Meyer et al. 2013). Areas of the brain associated with self-processing have also been shown to be active when processing information about a close other but not of a stranger (D'Argembeau, 2013; Mayer et al., 2013; Mitchell, Macrae, & Banaji 2006). Taken together, these studies may provide neurological support for cognitive representations of the other overlapping with the self.

Including the other's identities in the self refers to perceiving the other's place in the material and social world as one's own. Characteristics, memories, and experiences that happen to the other are included into the self as one's own. As a result of this, confusion may occur over whether traits and memories belong to oneself or the other (Aron & Fraley, 1999). For example, Aron et al., (1991) found that participants were just as likely to remember nouns attributed to close others as they were to remember nouns attributed to the self. Nouns attributed to distant others were less likely to be remembered than nouns attributed to the self and close others. Furthermore, in a meta-analysis of 65 articles, Symons and Johnson (1997) supported confusion over memories relating to the self and close others, but no confusion

over memories relating to non-close others and the self. Similarly, Mashek, Aron, and Boncimino's (2003) participants were given a set of traits and asked to provide ratings for how closely they related to themselves, a close other, and non-close others. When participants were later asked to engage in a surprise recollection test, findings demonstrated significant confusion of traits ratings relating to oneself and the close other. Participants showed no significant confusion between ratings of traits relating to a non-close other and the self or a close other. These findings support the argument that an increase in closeness leads to an increased difficulty in distinguishing the self from that of the close other. In summary, there is a substantial amount of evidence supporting the cognitive representation of the other overlapping with the cognitive representation of the self in close relationships.

1.4 Closeness and cooperation

Research has shown that relationships are perceived as more rewarding and rated higher for satisfaction and commitment when they satisfy the basic desire for self-expansion (Lewandowski & Aron, 2002; Nardone, Lewandowski, & Le, 2008). Likewise, in studies where the "other" is a romantic partner, ratings of closeness can be used as a prediction of relationship longevity. High ratings of closeness are also associated with marriage quality when the "other" is a spouse (Aron et al., 1991). Using the "Inclusion of the Other in Self" IOS scale recent research has shown that increased closeness leads to increased cooperation and likelihood of keeping a promise (Jiménez et al., 2020). Similarly, Fareri, Chang, and Delgado (2015) examined collaborative decision making and demonstrated that individuals are more likely to cooperate with a close friend compared to a stranger or a computer, even when the reinforcement rates are the same. Interestingly, increased closeness of the relationship was associated with increased reward related activity in the brain. Moreover, when one feels close to another, they are more likely to rate interactions with them as more

positive (Aron et al., 1991) and are more likely to divulge personal information (Slatcher et al., 2010; Wiese, Kelley, Cranor, Dabbish, & Zimmerman, 2011). Considering that information disclosure can be used as a behavioural measure of cooperation (Aron, Melinat, Aron, Vallone, & Bator, 1997), this further supports a relationship between closeness and cooperation. Aron et al. (1997) demonstrated how increasing perceptions of closeness between participants led to them to progressively disclose more information about themselves (Aron, Melinat, Aron, Vallone, & Bator, 1997). Wiese, Kelley, Cranor, Dabbish, and Zimmerman (2011) found that self-reported closeness was a better predictor of willingness to share information than observable features such as the interaction partner's age and sex, and frequency of interaction. Consistent with this, research has shown that during investigative interviews, increasing perceptions of closeness with the suspect facilitates cooperation, through increased intimacy towards the interrogator (Atkinson & Butcher, 2003). Taken together, previous studies have demonstrated a positive effect of increased closeness on cooperation is evident, which is to be expected if closeness mediates the relationship between NVM and cooperation.

1.5 Interpersonal closeness and mimicry

Previous research has suggested that closeness is positively correlated with NVM. In a study by Lakin, Jefferis, Cheng and Chartrand (2003), sets of participant and confederate dyads took turns answering a set of predetermined questions. The questions were either impersonal or became progressively more personal. The authors argued that sharing information about oneself and learning information about one's interaction partner increases feelings of interpersonal closeness. Thus, information sharing type was used to manipulate feelings of closeness across conditions. During the experiment, the confederate intentionally tapped their foot in both conditions. In the impersonal condition participants did not tend to

mimic the confederate's foot tapping. However, as the questions became increasingly personal, the amount of mimicry observed increased. From these findings, the authors concluded that the increase in closeness created through the questions becoming progressively more personal led to an increase in mimicry. Because the influence of closeness is the basis of this argument, it is critical that it is measured reliably. However, it is unclear whether a manipulation check was carried out to ensure that the information disclosed predicted closeness and that closeness was significantly different between the two conditions. This lack of a robust measure of closeness means that it is not possible to confidently argue that the increased mimicry observed was due to an increase in closeness and not due to an uncontrolled factor.

In contrast, a study by Kouzakova, Karremans, van Baaren, & Knippenberg, (2010) examined the effects of NVM on subsequent feelings of closeness and did carry out a manipulation check to ensure closeness was significantly increased. In their study, the experimenter either mimicked or avoided mimicking the posture and behavioural mannerisms of participants. Following the experiment, participants completed the interpersonal closeness scale (Aron, Aron, & Smollan, 1992). Results showed that feelings of interpersonal closeness were significantly higher in participants who had been mimicked compared to those who had not been mimicked. Kouzakova, Karremans, van Baaren, and Knippenberg's study supports the positive social consequences of mimicry, as indicated here through closeness (e.g., Ashton–James, Van Baaren, Chartrand, Decety, & Karremans, 2007; Gueguen, Jacob, & Martin, 2009; Van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009; Van Swol, & Drury-Grogan, 2017). However, although the study included a measure of closeness, the study did not include a measure of mimicry that showed there was a significant difference in the degree to which behaviours were mimicked in each condition. This is a significant limitation because

it is not possible to identify if the differences that emerged were due to NVM (and if so, how much NVM and of which body parts) or some other uncontrolled factor.

1.6 Overview of Experimental Chapters

In this chapter I have reviewed existing evidence for NVM as a cooperation enhancing mechanism. It is well established that NVM leads to several positive behavioural consequences, such as increased helping behaviour (Van Baaren et al., 2004), better outcomes in negotiations (Maddux et al., 2008), and increased perception that a person is understanding (Hess, Philippot, & Blairy, 1999). What is less understood, however, is the psychological mechanisms through which NVM works. There has been some debate over the influence of mechanisms such as similarity (Choi, Kornfield, Takayama, & Mutlu, 2017) liking (Stel & Vonk, 2010) and familiarity (Guéguen, 2009), with each of these mechanisms showing inconsistent results across the literature. However, emerging research suggests that NVM may increase cooperation through closeness (Van Baaren, Holland, Karremans, and Van Knippenberg, 2003; Lakin, Jefferis, Cheng, & Chartrand, 2003). This emerging evidence, while enticing, has examined this relationship without a reliable measure of both closeness and NVM. The current thesis addresses this limitation by testing the impact of NVM on cooperation through the process of closeness, in a more rigorous and robust way. Additionally, the previous literature has yet to address whether the effects of mimicry are consistent across the entire body, or whether the effects differ according to what body part is being mimicked. This thesis addresses this by examining the effects of NVM broken down by body part, this has never before been examined in such a way, thus is a novel contribution to the field. This is important to address because understanding what regions of mimicry are most related to increased closeness means that strategies aimed at increasing cooperation could be more effectively designed. For example, if mimicry of the lower body is more

significantly related to increased closeness than mimicry of the upper body, then strategies to increase closeness would be more successful if they focused on mimicry of the lower body, and vice versa.

Chapter 2

Chapter 2 begins by reviewing the limitations of traditional approaches to measuring NVM, including the manual coding of video footage by researchers, the holistic ratings of interaction by judges, and automated video analysis. This chapter then demonstrates why the use of motion capture systems enables a more sophisticated and robust measure of nonverbal behaviour. It describes the accuracy, usability, and reliability of the Xsens MVN motion capture system as one promising way of providing a more accurate measure of nonverbal behaviour. It is this system that is used in the current thesis to measure NVM.

Chapter 3

Chapter 3 tests the relationship between NVM and closeness using the new motion capture technology. It reports an experiment that examines how mimicry in face-to-face interactions manifests across relationships that differ in degrees of interpersonal closeness. Results showed a significant relationship between interpersonal closeness and NVM. As feelings of interpersonal closeness increased, levels of NVM increased. Moreover, when broken down into mimicry of discreet body parts, the right leg, left leg, the head, and the torso individually were significantly related to increased feelings of closeness, as what upper body NVM when considered as a whole. Prior to this thesis, no research had examined the distinct regions of mimicry and their relation to closeness, this is a novel contribution to the field. These data support my hypothesis that there exists a relationship between NVM and closeness and lays the groundwork for the remainder of the thesis.

Chapter 4

Chapter 4 extended our focus to examine the role of closeness as the process through which mimicry leads to cooperation. The chapter examined whether being mimicked to varying degrees—a large amount (hard mimicry), a subtle amount (soft mimicry), or not being mimicked at all—affected cooperation. This involved training three female confederates to mimic participants. They did so by mimicking those nonverbal behaviours that showed the highest frequency of being mimicked in chapter 3, namely foot shaking, face touching, leg crossing, stepping backward and forward, and posture changing. As such, in this study I created tailored mimicry training videos and guidelines which had not been done in such a robust way before. I measured cooperation in two ways: through exchanges in an economic context (i.e., a behavioural measure of cooperation) and disclosure of personal information. Findings showed that increased NVM led to a significant increase in closeness. However, the direct effect of NVM on both measures of cooperation was non-significant, as was the effect of closeness both measures of cooperation. There was also a nonsignificant mediation effect of closeness on the relationship between NVM and cooperation. Given that the measures of cooperation in this experiment were binary and involved participants being given the option to cooperate or not cooperate, it was not possible to examine how mimicry or closeness affected the degree of information disclosure. This could offer a potential explanation as to why we found a non-significant direct effect of NVM and closeness on cooperation and was examined in the next chapter.

Chapter 5

Chapter 5 addressed the limitations of chapter 4 by using a more sophisticated measure of cooperation, which allowed better measurement of the increase/decrease in

cooperation and how that related to the increase/decrease in NVM. Cooperation was examined in the terms of the degree of information provision. Although this chapter was originally intended to be carried out in-person, due to social distancing and national lockdown restrictions, this study was carried out virtually over Microsoft teams. Considering that previous research has shown that positive effects of mimicry can be obtained via virtual interactions (Bailenson & Yee, 2005; Maurer & Tindall, 1983), I hypothesised that the same processes would operate virtually as they do physically. As such, I adapted the mimicry training method used in chapter four for an online interaction, using the same three female confederates who had been trained for a previous study. The findings showed that NVM during interpersonal interactions significantly increases cooperation and willingness to disclose information with the mimicker, compared to not engaging in NVM, and that this effect was mediated by interpersonal closeness. Further, this study demonstrates that the tailored mimicry training videos and guidelines I had designed were effective in creating cooperation and can be done virtually. This has potentially important implications for investigative interviewing training.

Chapter 6

Chapter 6 extends beyond mimicry within the dyad by examining whether third-party observations of NVM between dyads would impact one's willingness to cooperation with the interacting dyad. This chapter also aimed to identify whether the effects of NVM worked through the same social processes as mimicry within the dyad (as shown in chapter three, four, and five). As a result of continued lockdown restrictions, it was not possible for this study to be carried out in-person, therefore this study was carried out virtually via Microsoft teams. My findings showed that participants were more willing to engage in conversation with observed dyads when the dyads engaged in more mimicry. My results also showed

closeness as a mediator of the effects of NVM on judgments. This thesis is the first work in the academic literature to demonstrate this and these findings have important implications for multi-party online interactions. This suggest that the evolved "social glue" function of NVM extends to third-party observations of NVM, and the effects of NVM may work through the same social processes as mimicry within the dyad. As such, the results provide new insight into the relationship between NVM and social judgements.

Chapter 7

Chapter 7 discusses how the findings of each experimental chapter link together. In this chapter, I also discuss how the overall findings of the current thesis have advanced current understanding of why NVM leads to increased cooperation, as well as the theoretical and practical implications of these findings.

CHAPTER TWO: THE AUTOMATIC MEASUREMENT AND ANALYSIS OF NONVERBAL MIMICRY

2.1 Abstract

The accurate and reliable measurement of human pose and movement is critical to the study of nonverbal mimicry. As I will show, much research has focused on manual coding measures. However, these are limited by issues of human error. As an alternative, this Chapter presents a case for the use of motion capture technology. Motion capture technology allows us to measure automatic 3D data of bodily movements and offers a more reliable method of measuring NVM. In the following sections I provide a detailed overview of the Xsens motion capture system and the methodological protocol that allows these data to be analysed to provide information on NVM.

2.2 Traditional approaches to measuring non-verbal mimicry

For decades researchers have sought to develop methods for the effective measurement and analysis of nonverbal behaviour. Until recently, researchers have relied on instructions, or observational methods such as the manual coding of behaviours from video recordings (Lausberg & Sloetjes, 2009). Manual coding of video recordings involves using sequential analysis to identify temporal patterns in observational data occurring over time (Bakeman & Gottman, 1997; Marono et al., 2017, 2018). Sequence analysis begins by first identifying the stimuli (e.g., video clips of individuals interacting) that can be analysed. Typically, a coding scheme is then developed so that each concrete behaviours or 'cues' shown in the stimuli can be categorised (e.g., specific hand movements or the tapping of the foot etc). The sequence analysis then measures transitions between pairs of behaviours between interactants (Ivanouw, 2007), for example, if person A first nods their head (antecedent behaviour), does person B nod their head shortly after (sequitur behaviour).

Manual coding of video recordings has been used in previous studies of NVM (Guéguen, Jacob, & Martin, 2009; Lakin, Chartrand, & Arkin, 2008; Van Swol & Drury-Grogan, 2017). For example, Stel, Van Baaren, & Vonk (2008) used manual coding procedures to check whether participants carried out instructions to properly mimic a target person from a video recording. In their study, the behaviours of the participant and the behaviours of the target person in the video were coded separately and then compared to calculate the mimicry scores. This involved watching a recording of the participants watching the video and coding whenever a behaviour was observed, that is, what behaviour was observed (e.g., shaking their head) and the time that it was observed (e.g., observed 26 seconds after recording began). The same was done for the video of the target individual, and all timed behaviours for the two conditions were compared to determine a total mimicry score. If the same behaviour observed in the target individual was then observed in the recording of the participant within a ten second period it was marked as a mimicry behaviour. If a behaviour of the target was not observed in the recording of the participant within ten seconds it was not marked as mimicry. This procedure has also been utilised in studies of emotional facial mimicry (Stel & Vonk, 2010). An advantage of manual coding of videos is that it allows for a non-invasive measure of nonverbal behaviour. Additionally, having video data allows for checks of reliability by having another researcher code the same data (Fujiwara et al., 2021).

However, despite their advantages, manual coding has several limitations. First, manual methods are extremely time consuming and tedious. As a result, researchers are limited in the range of behaviours they can practically code and may focus coding efforts on larger and more overtly noticeable movements than on smaller, more important ones (Feese et al., 2012; Van Der Zee et al., 2019). To avoid this bias, researchers can slow down video recordings and view them frame by frame (Condon & Sander, 1974; Marono et al., 2017).

However, this just adds to an already tedious process and may still not reveal microsecond behaviours. Additionally, the manual coding process is subjective, in that the coder must decide if an observed behaviour falls under a particular category, and this can lead to issues of reliability (Scherer & Ekman, 1982). The use of multiple raters is a proven method of improving reliability in manual coding. However, raters often rate different sections of the video with a relatively small overlap. For example, Stel and Vonk (2010) and Stel, Van Baaren, and Vonk (2008) had independent raters who were blind to the study conditions code different sections of the video recordings with only 15% overlap. This does little to reduce the issues of reliability.

An alternative method to the manual coding of video data involves holistic ratings by judges (Criss, Shaw, & Ingoldsby, 2003; Grammer, Honda, Jüette, & Schmitt, 1999). Holistic ratings involve trained judges watching the video recorded interaction and providing ratings of the interaction (i.e., how much mimicry they perceived to occur). Although like manual coding methods, holistic ratings do not involve coding per behaviour but instead ratings will typically be given as a percentage of perceived mimicry or using a Likert scale. Thus, holistic ratings appear more efficient than manual coding due to less time required for analyses. However, the training of judges is extensive and time consuming (Criss et al., 2003). Additionally, holistic ratings are not able to provide an accurate account of the actual mimicry occurring, only an account of perceived mimicry. This is a problem because mimicry is often subtle and may go unrecognised (Chartrand and Bargh, 1999; Dimberg 1990; Kugiumutzakis, 1996).

Additionally, in some studies, no measurement of nonverbal behaviour is carried out, with researchers assuming an instruction to the participant changed their behaviour (Fischer-Lokou, Martin, Guéguen, & Lamy, 2011). Shaw et al. (2015) instructed confederates to either mimic or not mimic participants during an interaction and captured interviewees' feelings

towards the confederate post interview. The study failed to include a manipulation check to establish if the confederate managed to mimic the participants' nonverbal behaviour, and as such, it is not clear if the findings they report can be attributed reliably to the effects of nonverbal mimicry. As I show in Chapter 4, successful mimicry of another person's behaviour takes a minimum of 12 hours of training. Thus, having no manipulation check poses concerns over the accuracy of mimicry.

To overcome some of the limitations of manual approaches and studies in which no measurement of nonverbal behaviour is carried out, researchers have begun using automated video analysis (Paxton & Dale, 2013; Poppe, 2007). For example, Ramseyer and Tschacher (2011) demonstrate the utility of Motion Energy Analysis (MEA) in a study of nonverbal synchrony during psychotherapy. This method involves using video analysis software to analyse recorded motion energy through 'frame differencing', that is, differences in grey-scale pixels between consecutive video-frames (Grammer et al., 1999). It has been used successfully in clinical research studies (Kupper et al., 2010; Nagaoka & Komori, 2008; Ramseyer & Tschacher, 2008, 2011). For example, Ramseyer and Tschacher, (2011) used MEA to demonstrate that nonverbal synchrony between patient and therapist during psychotherapy was associated with increased ratings of quality and positivity.

When using MEA to examine NVM, participants must be clearly separated into two regions during experimentation. Video recordings of each region are analysed frame by frame, with changes across frames indicating body motion. This technique has the advantage of reducing the need for researchers to handle raw data and is designed to be an effective and unobtrusive method of quantifying nonverbal behaviour. However, it has several limitations. When studying interactions, clear separation between the actors is required for accurate motion-energy detection of each individual. This is problematic because, the motion-energy of each individual will overlap if they get too close and it will not be possible to separate the

two streams. Additionally, factors such as unstable light conditions and illumination, will affect the quality of the analysis as it reduces the number of pixels, meaning that small movements may be missed (Varkey, Pompili, & Walls, 2012). The camera viewpoint also limits the ability to track movement direction and velocity as fewer pixels change with movement towards the camera, thus such movements may be underestimated or missed entirely.

2.3 Motion capture systems

An alternative automatic technique to using video analysis relies on the use of motion capture systems (Feese, Arnrich, Tröster, Meyer, & Jonas, 2012). Motion capture systems involve transferring the movement of a target individual to a digital character. Motion capture systems can utilise different methods of tracking movement. For example, optical systems involve markers positioned on the body being tracked with cameras. Video/markerless systems instead use software to track the target's movement. Other systems that do not require cameras are 'non-optical' and measure Inertial motion using body worn sensors.

Table 2.1, as adapted from Poppe, Van Der Zee, Heylen, and Taylor (2014), shows a range of automatic methods that have been developed and the types of devices used to capture nonverbal behaviour. Motion capture technology allows for a robust analysis of full body motion, and the examination of discrete nonverbal behaviours such as hand gestures (Feese, Arnrich, Tröster, Meyer, & Jonas, 2012).

Table 2.1 *Overview of body motion capture devices* (table adapted from Poppe, Van Der Zee, Heylen, & Taylor, 2014).

Device Characteristics Full body	Type	Example Devices	Example Studies
Yes	Marker	Vicon MX, MotionAnalysis Raptor, Advanced Realtime Tracking ARTTRACK, Optitrack Arena, PhaseSpace Impuls X2, Phoenix Technologies Inc. Visualeyez, Qualisys Oqus, Optotrak 3020	Fotedar & Ghosh, 2017; Liu, Dong, Zhang, & El Saddik, 2018; Manternach et al., 2012; Orendurff et al., 2018; Slawinski et al., 2013; States & Pappas, 2006
Yes	Inertial	Animazoo IGS, Ascension MotionStar, Xsens MVN, YEI Technology 3-Space, Rokoko Smartsuit Pro	Kleinsmith et al., 2011; Krishnan et al., 2009; Malleson, Collomosse & Hilton, 2020
Yes	Vision	Microsoft Kinect, Ipi Soft, Organic Motion Openstage, PhysCap	Burba, et al., 2012; Kistler et al., 2012; Lala, et al. 201; Mead et al., 2013; Shimada, Golyanik, Xu, & Theobalt, 2020
No	Inertial	Ascension TrakSTAR, Polhemus Liberty Latus, Sparkfun Electronics Witilt	Dotsch & Wigboldus, 2008; Feese et al., 2012

2.3.1 Optical systems

Optical motion capture systems involve the use of small sensors/markers that are positioned across the body at specified locations and tracked in 3D by camera systems that assemble the data into an approximation of the actor's motion. A minimum of 8 cameras are needed for full body motion capture, although typically between 16-24 are used. There are two types of optical motion capture systems: Optical-passive and Optical-Active. Optical-Passive systems use retroreflective markers that are positioned on the actor’s body and tracked by infrared cameras. Lavelle, Healey, and McCabe (2013) showed the utility of Optical-passive markers to investigate social interaction and interpersonal rapport in schizophrenic individuals compared to healthy individuals. Their study involved participants

wearing a special top and a cap with 27 reflective markers attached to track the body motion of participants during a moral dilemma task. This approach has the advantage of being inexpensive and allows for good flexibility and viability. However, it is limited by the fact that the use of passive markers can lead to confusion across markers. One marker may be accidently 'swapped' for a different marker during tracking, causing distortions in recordings of body motion. Also, all other reflective surfaces in the shooting area need to be eliminated so as to avoid false reflections (i.e., other surfaces being picked up as markers) (Roth, Stauffert, & Latoschik, 2019).

As an alternative, researchers have used Optical-Active markers. Optical-active systems use infrared light-emitting diodes (IRED) which are tracked by special cameras. Optical-Active markers avoid distinct markers being confused with one another by using distinct frequencies, meaning they are not restricted to a dark studio and can be used in natural light (Maletsky, et al. 2007; States & Pappas, 2006). However, due to the use of LEDs, these systems require a battery or charger of some kind. Although marker-based technologies have been shown effective for quantify human motion (Maletsky, Sun, & Morton, 2007; Wiles, Thompson, & Frantz, 2004), they require both passive and active markers to be visible to a minimum of two cameras to create a 3D image/ measurement. Not only does this require many cameras for each recording session, creating an intrusive and unrealistic environment, it also requires cameras to have good resolution, be of high quality, and of adequate speed to ensure analyses are accurate.

2.3.2 Markerless

Markerless technologies have attempted to measure full-body movement without the need for an intrusive and unrealistic environment using or multiple cameras. Markerless technologies instead rely on depth sensitive cameras rather than physical body markers to track peoples' movements. Depth sensitive cameras differ from ordinary cameras as they use

a pattern of near-infrared light to capture depth. Hence, each pixel captured contains information about the object's distance and it is possible to reconstruct objects and movements in 3D. A commonly used markerless system is the Microsoft Kinect. Using a Red Green Blue (RGB) camera, and a depth-sensor with an Infrared (IR) light source, Kinect can produce three-dimensional position data in real time by generating its own body markers made of light and tracking the target's distance and movements (Pheatt & McMullen, 2012). Microsoft Kinect have also released a Software Development Kit (SDK) which enables skeletal tracking based on estimating body parts and joints from depth data (Shotton et al., 2011). Researchers have demonstrated the utility of Microsoft Kinect SDKs in tracking body motion across several contexts, such as interactive storytelling (Kistler, Sollfrank, Bee, & André, 2011), rehabilitation therapy (Lange et al., 2011), and improving the realism of video games (Suma et al., 2011). Although the skeletal tracking capabilities have shown a high degree of accuracy in representing body posture and hand gestures (Pisharady & Saerbeck, 2013), more subtle motions such as movements of individual fingers and fidgeting show poor resolution quality and inaccuracy of data (Burba et al., 2012). Additionally, markerless systems have the draw-back of exhibiting more real-time and final data error when compared to inertial devices (Ferrari et al., 2010), as well as showing lower accuracy when compared to marker-based systems (Ceseracciu, Sawacha, & Cobelli, 2014).

2.3.3 Inertial

Inertial motion capture devices involve body worn sensors, sometimes known as Inertial Measurement Units (IMUs), that estimate a person's relative orientation using gyroscopes and a person's relative movement using accelerometers. Subsequent data is transmitted wirelessly to a computer or smart device to capture and reconstruct human pose in 3D. No external cameras or infrastructure are required meaning that inertial motion capture can be used anywhere (Welch & Foxlin, 2002). Inertial devices address the limitations of

poor resolution quality related to markerless systems by measuring full-body motion through sensors worn in a suit or straps. The usefulness of this approach was shown in a study by Feese, Arnrich, Tröster, Meyer, and Jonas (2012), who used this type of system to study the underlying micro-level behaviours that support team performance. Using wearable motion sensors, they were able to automatically measure nonverbal behaviour with a high degree of accuracy through small micro-movements of specific limbs. Using these nonverbal behaviours cues they were able to show that 'considerate' leaders mimic head nods and face touches of their followers more often than 'authoritarian' leaders. However, the use of a tight-fitting suit may lead to problems relating to restricting subject's movement, and consequently causing unnatural behaviour/movement (Poppe et al., 2014). To overcome the potential problem of a tight-fitting suit, researchers have tested the performance of these sensors when worn on straps fixed to the top of clothes. Liu, Zhang, Zhang, and Zhu (2020) used wearable inertial sensors on top of clothes to examine motion-recognition during highly dynamic movements such as running, jumping, boxing, and kicking. The authors concluded that the systems showed excellent performance and high accuracy in the reconstruction of human pose and dynamic motion recognition. The Xsens MVN Awinda motion capture system is a full-body human measurement system based on inertial sensors, which uses 17 wireless sensors fitted on the body with adjustable straps. The lightweight wireless sensors remove the need for a tight fitting, thus do not restrict human movement. Robert-Lachaine, Mecheri, Larue, and Plamondon (2017) examined the use of Xsens motion capture systems in ergonomic applications and supported such systems as a valid and reliable tool to track human movement. Likewise, Schepers, Giuberti, and Bellusci (2018) examined the performance of Xsens MVN motion capture systems to capture full-body movement during activities such as running, jumping, squatting, crawling, and cartwheeling. Findings showed that Xsens MVN systems were able to track human movement reliably and consistently

across any environment, including severe magnetically distorted environments. Given the accuracy, usability, and reliability of the Xsens MVN system, as demonstrated above, these were used in the current thesis to measure nonverbal behaviour and from this, take a measure of mimicry.

2.4 Automatic Measurement of Human Body Motion: Xsens MVN Awinda System

The Xsens MVN motion capture system includes 17 wireless sensors fitted on the body with adjustable straps. Placement of sensors are on the front of participant's forehead (attached to a headband); shoulders and sternum/neck (attached to Velcro on a short-sleeved Xsens t-shirt). The remaining sensors were attached using fastening straps and were placed on the upper arms, forearms, hands, thighs, lower legs, feet, and pelvis. In the current thesis, MVN Animate/Analyze™ software was used alongside the wireless sensors. The inertial sensors record acceleration 120 times per second in three dimensions at a frame rate of 120Hz. Before any recording of human movement can take place, a calibration phase must be carried out. This is done to distinguish relative sensor locations, and to align them to the global reference frame. The calibration phase was identical for all participants and involved standing in a 'T-pose' (stood up straight with theirs arms reaching out to the sides) until the sensors registered the location as the origin, (0,0,0) in the x,y,z plane. Once correctly calibrated, the inertial sensors are able to create a full 3D motion measurement of the 23 joints. Thus, a real-time, reliable, and accurate analysis of nonverbal behaviours is possible.

2.4.1 Nonverbal data

Raw nonverbal data recorded by the Xsens systems is exported in mvnx format and imported into MATLAB to allow for data processing. Each data file contains the (x,y,z) coordinates and timestamps for each of the 23 joints. Behavioural data captured by the Xsens

motion capture system is examined using the Automated Measurement and Analysis of Body Motion (AMAB) method (Poppe, Van Der Zee, Heylen, & Taylor, 2014). This method uses a standardised representation of the movements in data form, using MATLAB. The basis of AMAB is that the human body can be described in terms of a series of body parts and joints. Body parts being shapes with a certain length, and joints being single points in space. A tree-like representation of the human body is formed using AMAB from the body parts and joints together. The displacement and rotation of the joints with respect to this tree denotes human movement. For example, if a joint starts at 0,2,1 on the tree and then moves to 1,2,2 on the tree, this would be measured as movement and this movement would be captured in the data as 1,0,1. In this way, the Xsens motion system creates a digital representation of the position and movement of each limb (for a detailed review see Poppe, Van Der Zee, Heylen, & Taylor, 2014). AMAB results in numerical representations of the body's position over time. Using the AMAB method to calculate mimicry scorers, as per Poppe et al. (2014), required the data to first be checked for data distortions and to be normalised.

2.4.2 Data distortions

During data collection it is possible for data to become distorted as a result of measurement noise and for longer-term inconsistencies to appear in the data due to equipment or transmission failure. If the failure time is short, it is possible for the missing measurements to be interpolated from the measurements prior to and following the failure through a process of using moving median filters. This involves collating all collected data point within a particular window (number of frames) and replacing them with the median value of the neighbouring data points of the same window length (Poppe et al., 2014). Using the AMAB approach, the moving window was between 0.25 to 0.5 seconds. Using a median filter such as this reduces the risk of extreme values skewing subsequent analysis and reduces the loss of important information (Fisher et al., 2003). In addition, data points that exceed the

possible reading values (0.25 to 0.5 seconds) for a sensor represent electronic recording errors and need to be removed.

2.4.3 Normalization

It is important to take into account the differences in the amount of free space the person has to move around and the duration of recording, both within or between recording sessions, and within or between subjects, when comparing body movements. This is because each of these factors have been shown to introduce measurement error into the data. One solution to minimise distortions within the data, adopted in AMAB, is to normalise the recordings. Two types of normalisation were used: normalisation in time and normalisation in space.

2.4.4 Normalization in time

Xsens records at a high fixed frame rate, e.g., 120 Hz of recordings per second. This equates to over 7,200 data points per minute, which is impractical to work with, and as shown by researchers, unnecessary to gain a reliable measure of nonverbal behaviour (Poppe et al., 2014). To deal with this, research suggests that the method of down-sampling should be applied (Poppe, 2007). Simply, downsampling reduces the number of frames within the recording, thus enabling a more manageable analysis. Accordingly, frame rate alignment and synchronization are required for reduction of sampling rate. Frame rate alignment refers to the measurements in each data stream (data recorded by each sensor) being resampled in time to equally fit a fixed rate. Synchronisation of data is then important to ensure that all data streams run for an identical length of time. This is vital to ensure that the two data streams can be matched efficiently without the inclusion of noise data. This involves identifying the latest start point and earliest end point across recordings and trimming data accordingly.

Using Xsens MVN systems, once data has been recorded, it is possible to specify a chosen frame rate to save the data, to ensure that all data streams align. For the current thesis, a frame rate of 60 Hz was chosen. This was chosen because it is still a relatively high number of measurements recorded per second, and results in minimal loss to human-perceivable movement of individual limbs. This is important because mimicry may occur quickly and subtly, reducing the frame rate too much may cause these behaviours to be missed. MVN Awinda is the software used to process the motion capture data received from the Xsens MVN hardware (17 wireless sensors).

2.4.5 Normalisations in space

A full-body pose can be described by the positions of the joints. A convenient way to express joint positions is to use global representations. This involves joint positions being expressed as three position values corresponding to the distance from the origin (i.e., the point (0, 0, 0)) along each of three pre-defined orthogonal axes (i.e., x, y, z). When working with interaction data of multiple subjects, it is important to be able to compare the postures of each subject in different points throughout the interaction. Thus, the global position of subjects needs to be normalised in space. The absolute distance between subjects is not important when comparing their poses, making the normalisation of data in space highly practical.

Normalisation can be applied to both body position and orientation, as demonstrated in Figure 3. When using Xsens motion capture systems, poses are normalized for position by mean centering all position measurements of each joint relative to the pelvis. The pelvis thus acts as the root of the body. The location of the root joint *P,* in the recording space is translated to (0, 0, 0).

Figure 2.1 *Illustration of normalisation of body position (I) and orientation (II).*

When concerned with the similarity of individual's poses, it is important to consider that the orientation of individual will affect the resulting pose comparison. Thus, rotating the pose of one of the individuals 180 degrees around a vertical axis eliminates this issue.
To normalise the data in such a way, poses must first be normalised for position, with the y-axis pointing upward. The joints of one individual are then rotated around the y-axis 180 degrees so that the individual faces the positive x-axis. Accordingly, hips are placed parallel to the z-axis. Next, joints are rotated around the y-axis so that the body pose of person A is identical to that of person B.

2.4.6 Measuring Nonverbal Mimicry

The degree of nonverbal mimicry between interaction partners can be calculated once pose differences across time have been identified. It is possible to identify a single 'pose difference' score for the 23 joints of a subject, by summing the distances between each of the joints relative to the pelvis. The distance between each joint individually is calculated using Pythagoras theorem.

When the poses of both subjects are identical, 'pose difference' score will have a value of zero. The more dissimilar poses become, the further scores will be from zero. This

will result in a sequence of difference values for each determined measure of time. However, this is problematic because it represents a comparison only of subjects' poses at the same moment in time. Considering that mimicry can occur following a short time delay (usually up to 10 seconds; Chartrand & Lakin, 2013; Lakin et al., 2003; Stel et al., 2009), any analysis must account for 'lag' and variation in the immediacy of mimicry.

The issue of variations in the timing of mimicry can be addressed using a statistical procedure called Dynamic Time Warping (DTW). Dynamic Time Warping (DTW) refers to a set of algorithms that compares a series of values with each other. The DTW analysis operates on a matrix *M* with elements *Mi,j*. Here *i* corresponds to the *j''th* pose measurement of person A, and *j* corresponds to the j'th pose measurement of person B. *Mi,j* is then the difference between the two poses (Van Der Zee, 2013). As mentioned earlier, the use of this technique allows for the calculation of pose similarity across both the same moment in time and different points in time. When dealing with two sets of time series data, DTW determines the extent to which one is stretched or compressed in order to resemble the other as much as possible. Simply, DTW is a form of correlation that computes the optimal alignment in time (Rabiner & Juang, 1993) between the data stream of person A to person B. The DTW package can be accessed through http://dtw.r-forge.r-project.org. Other methods for characterizing patterns in time series do exist, for example recurrence quantification analysis (Coco, Mønster, Leonardi, Dale, & Wallot, 2020). However, due to compatibility with the AMAB method, for the purpose of this thesis only DTW was used.

When considering how to align two data streams, it is important to limit the number of consecutive elements which are "skipped" in either time series. Alignments are typically achieved through the duplication of elements. This refers to allowing a single time point in the data stream of person A to match multiple (consecutive) elements in the data stream of person B, or vice-versa. The number of repeated elements that are matched or skipped effects

the subsequent slope of the warping curve. Thus, step patterns are used to determine the alignment steps, and restrict allowed transitions between matched pairs at each alignment frame. Numerous step patterns exist, the choice of which depends on the type of application, data, and frame rate. The current thesis used the normalized and unbiased Rabiner and Juang step pattern 6C. This was chosen because it allows for moderate changes in the alignment the body motion data streams (Rabiner & Juang, 1993). For this step pattern, the next alignment frame is either the next frame in both data streams, or two frames advanced in one data stream and three in the other. If the latter is applied, then the time scales will be compressed and expended. For example, after alignment, 10 seconds of data from person A can be matched to a minimum of 6.7 seconds and a maximum of 15 seconds of data from person B. Notably, both data streams will start and end at the same time, limiting the maximum difference in temporal alignment. The average value of the pair-wise (Euclidian) distance between the two data streams at each alignment frame results in the DTW score for the interaction. In the current thesis, the higher the DTW score, the less nonverbal mimicry occurred between person A and person B across the interaction.

2.5 Conclusion

When looking to examine the effects of nonverbal mimicry on subsequent behaviour, a robust measure of human movement is essential. Traditional approaches, which relied on methods such as manual coding of video recordings or holistic ratings by judges, have been shown to be unreliable measures of nonverbal mimicry and prone to human error. The development of motion capture systems has allowed for a robust analysis of full body motion. Although optical and markerless motion capture systems have led to great advancement in measuring human movement, inertial systems allow for greater resolution quality in measuring more subtle motions and a higher degree of accuracy in final data. Thus, two Xsens motion capture suits were used to study nonverbal mimicry during interpersonal

interactions across the current thesis. The AMAB method was used in all subsequent analyses.

CHAPTER THREE:
THE EFFECTS OF INTERPERSONAL CLOSNESS ON NONVERBAL MIMICRY DURING FACE-TO-FACE INTERACTIONS

Understanding how to influence cooperation effectively could be beneficial in several contexts, such as investigative interviewing where facilitating cooperation have been shown to increase information elicitation (Granhag, Kleinman, & Oleszieiwicz, 2016). As reported in Chapter 1, research have shown that NVM can be used to increase cooperation (Brimbal, Dianiska, Swanner, & Meissner, 2019; Shaw et al., 2015), and my proposal is that this relationship can be explained by changes in interpersonal closeness (Jefferis, van Baaren, and Chartrand, 2003; Van Baaren, Holland, Karremans, & Van Knippenberg, 2003). Consistent with this, research suggests that nonverbal mimicry (NVM) promotes feelings of closeness, which in turn result in positive relational experiences. For example, research shows that the feeling of closeness is positively related to cooperation during negotiations (Atkinson & Butcher, 2003), personal information sharing (Slatcher, 2010; Wiese et al., 2011) and likelihood of keeping a promise (Jiménez et al., 2020). However, as shown in Chapter 2, existing evidence lacks a robust measure NVM, and empirical data on the role closeness plays within this relationship is lacking. Across three studies, we seek to examine the relationships between dyadic NVM and interpersonal closeness, and the impact of this relationship on cooperation. Study 1 seeks to establish the relationship between NVM and interpersonal closeness. Studies 2 and 3 test closeness as a mediator of the effects of mimicry on cooperation; moving from an exchanges in an economic context to information provision in a forensic context.

3.1 Nonverbal mimicry and Closeness

NVM is the imitation of behaviour that partners engage in during an interaction (Chartrand, & Van Baaren, 2009). It is often considered a ‘social glue’, due to its ability to help bind people together and facilitate harmonious interpersonal interactions (Hale &

Antonia, 2016; Lakin, & Chartrand, 2003; van Baaren, Holland, Kawakami, & van Knippenberg, 2004). The positive social consequences of nonverbal mimicry are well established within the literature (Hess, Philippot, & Blairy, 1999; Maddux et al., 2008; Swaab, Maddux, & Sinaceur, 2011; Valdesolo, Ouyang, & DeSteno, 2010). For example, Guéguen (2009) examined mimicry during sessions of speed-dating between female confederates and male participants. They found that participants evaluated the interaction more positively and reported greater desire to meet again when their behaviour was mimicked, compared to when their behaviour was not mimicked or only their verbal expression was mimicked.

Studies have also shown that NVM in a prior interaction predicts cooperation in a subsequent joint-action task (a task that requires interacting individuals to coordinate their actions) (Valdesolo, Ouyang, & DeSteno, 2010), and that mimicking during negotiations results in better outcomes (Maddux et al., 2008; Swaab, Maddux, & Sinaceur, 2011). Additionally, the positive effects of mimicry are not limited to the person being mimicked. For example, Stel and Vonk (2010) showed that during dyadic interactions, both individuals rated the interaction as more positive and felt a stronger bond with one another if one of the individuals had engaged in NVM, compared to if they had not. Likewise, Maddux, Mullen, and Galinsky (2008) showed that NVM facilitated negotiators' ability to obtain favourable negotiation outcomes. The authors showed that individuals who engaged in strategic mimicry were able to increase individual gain but were also more likely to generate a deal that benefited both parties.

One of the explanations offered for the positive effects of mimicry on positive behavioural outcome is that it generates a sense of closeness and the associated processes of reciprocation (Hale & Antonia, 2016; Lakin, & Chartrand, 2003; van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Closeness concerns the interconnectedness of the self

and other (Aron et al., 1992; Ridley, 1993). According to Aron's self-expansion model (Aron & Aron, 1986), people are motivated to expand their 'self' to include resources and identities that assist in the achievement of goals. One way in which people do this is through close relationships. Close relationships allow an individual's self to expand through a process of inclusion of the other in the self; as an individual becomes closer to their relationship partner the partner becomes part of the self (Weidler & Clark, 2011).

Close relationships tend to be distinguished from relationships defined by lower levels of closeness through a sense of ownership over the relationship partner, shared identity, and interconnectedness (Aron & Aron, 1986; Aron, Aron, & Norman, 2001). For example, social comparison researchers have shown that when closeness is created by a priming manipulation, one may experience the other's outcomes as their own (McFarland, Buehler, & MacKay, 2001; O'Mahen, Beach, & Tesser, 2000). Consequently, closeness is a strong predictor of relationship longevity, and marital quality when the 'other' is a spouse (Aron et al., 1991). Additionally, individuals with a stronger interdependent self-construal exhibit a stronger preference for closeness across their relationships (i.e., family, friendship, romantic [Aron, Aron, & Smollan, 1992; Gardner, Gabriel, & Hochschild, 2002; Oyserman, Coon, & Kemmelmeier, 2002; Vorauer & Cameron, 2002]).

Indirect support for the relationship between NVM and closeness comes from studies that examine in-group and out-group interactions. Yabar, Johnston, Miles, and Piles (2006) investigated the impact of group membership on unconscious NVM and found that participants mimicked face rubbing behaviours of a confederate whom they considered to be an in-group member significantly more than if they considered them to be an out-group member. Similarly, van Schaik and Hunnius, (2016) examined the effects of group membership on NVM in 4- to 6-year-old children. In their study, the children were given a

group allocation based on what colour paper they liked best out of either blue or yellow. Children were then shown two video presentations, one involving an in-group member who was wearing the in-group colour clothes and one involving an out-group member wearing the out-group colour clothes. Children were also told what group each individual belonged to. Findings showed that children engaged in NVM of in-group models significantly more than they did for out-group models. While this research does not identify the process through which NVM has its effect, other work examining groups has shown that individuals report greater feelings of closeness towards in-group members compared to out-group members, and that this effect persists irrespective of how much they see the person (Turner et al., 1987; Wright et al., 1997). In-group members are directly linked to the cognitive representations we have of ourselves whilst outgroup members are seen as different to us (Smith & Henry, 1996), thus suggesting that NVM is more likely to occur between individuals who perceive their interaction partner as a close other, than if they do not feel closeness towards.

Direct support for a relationship between NVM and closeness comes from research examining reciprocal self-disclosure. For example, in a study by Lakin, Jefferis, Cheng, and Chartrand (2003), sets of participant and confederate dyads took turns answering a set of predetermined questions. The questions were either impersonal or became progressively more personal. The information sharing type was used to manipulate feelings of closeness across conditions, as the authors argued that sharing information about oneself and learning information about one's interaction partner increases feelings of interpersonal closeness. In both conditions the confederate intentionally tapped their foot. As the questions became increasingly personal, the amount of mimicry observed increased, whereas mimicry did not increase in the impersonal condition. Further support for this relationship comes from research exploring the role of nonverbal mimicry in building social relationships. For

example, Chartrand and Bargh (1999) showed that participants who were mimicked by a confederate reported greater feelings of closeness towards the confederate and towards others in general, compared to those who were not mimicked. Stel and Vonk (2010) examined the bidirectional effects of mimicry in dyadic interactions. Participant dyads were given the role of observer or target. Targets watched a five-minute video while the observer received instructions to either mimic or actively avoid mimicking the targets behaviours. Results showed that both the mimicker and mimikee reported greater feelings of interpersonal closeness in the mimicry condition compared to the non-mimicking condition.

Although this may suggest a relationship between mimicry and closeness, there are several methodological concerns with this research. For example, it is unclear whether a manipulation check was carried out to ensure that the conditions significantly differed in closeness. Additionally, the authors did not account for foot shaking as a typical response to anxiety (Kendall, 1994; Wang et al., 2011). Thus, it is possible that the foot shaking observed were due to anxiety as the questions became increasingly personal rather than unconscious mimicry. However, the reliability of the results reported by Stel and Vonk (2010) may be limited by methodological issues. For example, during the experiment, a camera was hidden in the smoke detector in the middle of the room on the ceiling, and recordings were later coded to check that mimicry was carried out effectively. This is a potential limitation because the position and location of the camera would presumably allow for a birds-eye view rather than a direct view of the participant's body, meaning that small behaviours may have been missed. Likewise, the manual coding of videos may lead small behaviours to go unnoticed due to limits in the range of behaviours researchers can practically code, meaning that researchers may focus coding efforts on larger and more overtly noticeable movements (Feese et al., 2012; Van Der Zee et al., 2019).

An additional limitation of Stel and Vonk's, (2010) study is that it is unclear what behaviours participants were instructed to mimic and why those behaviours were chosen. Specifically, whether it was mimicry of the whole body, or a discreet area. This is important because it is currently unknown whether there are regions of mimicry (discreet body movements) more significantly related to closeness than others. This may have implications for the effectiveness of mimicry in different contexts, for example when a person is sitting at a desk only upper body mimicry would be possible, compared to when they are sat with no desk and their lower body visible, or stood in an open space.

3.2 Study 1

To address these limitations, Study 1 will examine the relationship between NVM and closeness using motion capture technology to ensure a robust measure of NVM. It examines how NVM varies across different forms of established relationships—strangers, acquaintances, and romantic partners—chosen as previous research has shown that they differ significantly on measured relationship closeness scores (Gächter, Starmer, & Tufano 2015). I hypothesised that there will be a linear increase in mimicry from strangers to acquaintances to romantic partners (H1).

Study 1 also addresses whether the effects of mimicry are consistent across the entire body, or whether the effects differ according to what body part is being mimicked. To my knowledge, research considering closeness has yet to examine NVM of discreet areas compared to full-body mimicry, thus no formal hypothesis is made regarding mimicry broken down by body part.

3.3 Method

3.3.1 Participants

A power analysis based on the $r = .582$ effect reported by van der Zee et al. (2020) suggested a sampling of 23 dyads per condition would be adequate to achieve a 0.8 effect assuming an error rate of alpha = .05. Accordingly, 138 participants ($n = 78$ female, $n = 60$ male), were recruited through word-of-mouth and advertising. All participants were undergraduate students and reported a mean age of 22 years ($SD = 2.57$; Range 19 - 26). Participants were assigned to either a 'Strangers,' 'Acquaintances,' or 'Romantic partners' condition based on their self-declared relationship with their interaction partner (46 participants per condition). Strangers had no previous contact and had not met prior to the experiment. Acquaintances were classmates who had previously interacted but had not worked collaboratively together. Romantic partners were couples who has been romantically involved for a minimum of six months. Stratified random sampling was carried out to ensure that each condition consisted of an equal number of same sex and opposite sex pairs to account for the fact that mimicry may be moderated by sex differences (Lehane et al., 2015). Specifically, in each condition there were 17 opposite sex dyads, five all-female dyads, and one all-male dyad.

3.3.2 Materials

Closeness. Closeness was measured using the pictorial Inclusion of the Other in the Self (IOS) scale (Aron et al., 1992). The development of the IOS was influenced by previous work demonstrating the construct of interconnected selves (Levinger & Snoek, 1972; Pipp, Shaver, Jennings, Lamborn, & Fischer, 1985). The IOS scale presents participants seven pairs of circles ranging from not touching at all to almost entirely overlapping. The circles represent one's perception of their relationship with the other. The greater the overlap in circles a participant chooses, the great they perceive the closeness between themselves and

the target (in this case, their interaction partner). Although brief, the IOS has proven a reliable measure of the subjective closeness of relationships (Gächter, Starmer, & Tufano, 2015), and is as effective as more complex multi-item measures (Aron et al., 1992; Le, Dove, Agnew, Korn, & Mutso, 2010; Mashek, Cannaday, & Tangney, 2007; Tsapelas, Aron, & Orbuch, 2009).

Riddles. Participants were required to solve a series of riddles as part of the task. Nine riddles were retrieved from https://www.lolwot.com/12-incredibly-hard-riddles/ and printed on laminated cards. An examples riddle is: *"I have keys but no locks. I have a space but no room. You can enter but can't go outside. What am I?"* The nine riddles were chosen randomly, with varying degrees of difficulty (as rated by the website). The use of riddles reflected our desire to observe communication among pairs in a way that was relatively unconstrained, and because prior research has shown that mimicry facilitates performance on collaborative tasks (Ashton-James & Chartrand, 2009).

Measuring mimicry. We captured participants nonverbal movements using Xsens MVN motion tracking system. Xsens motion capture is a full-body human measurement system that uses 17 inertial sensors, fitted across the body to record acceleration and direction of movement up to 120 times per second. Placement of sensors are on the front of participant's forehead (attached to a headband); shoulders and sternum/neck (attached to Velcro on a short-sleeved Xsens t-shirt). The remaining sensors were attached using fastening straps and were placed on the upper arms, forearms, hands, thighs, lower legs, feet, and pelvis. After a calibration phase, to distinguish relative sensor locations, the inertial sensors are able to create a full 3D motion measurement of 23 joints. Following the procedure outlined in Poppe, Van Der Zee, Heylen, and Taylor (2014), we measured mimicry as follows: (1) data were down-sampled and trimmed to have the same start and end point; (2) for each participant, we mean-centred all joint locations to the pelvis, thereby creating a set of

observations where differences in participants' body locations reflects non-alignment within space; (3) difference in space scores between participants were calculated and summed: a greater score indicating less overlap between the individual's poses; (4) the difference data were submitted to a Dynamic Time Warping (DTW) comparison. DTW functions through a matrix calculating the optimal alignment in time (Rabiner & Juang, 1993). This matrix representation thus allows us to calculate how similar poses are at the same moment in time, but also how similar poses were for different moments in time. To do this, pose differences are summed to create a single 'pose difference' score for the 23 joints. A score of zero would indicate identical poses between participant A and B. Thus, the higher the score, the greater the difference in poses.

3.3.3 Procedure

Participants in the romantic partners condition arrived together at the lab, whilst acquaintances and strangers arrived separately. On arrival at the lab, participants were told the study was investigating effective communication during a puzzle solving exercise. They gave their consent and were fitted with the Xsens MVN sensors. Participants were told the Xsens MVN monitored body temperature and heartrate to limit participants concern about their nonverbal behaviour. Once the Xsens suits were fitted and fully calibrated, participants were led into a connecting room that displayed the nine riddles on a wall. The riddles were fixed to the wall to avoid participants trying to pick them up them during the experiment as this would affect their pose, thus effect mimicry scores. Participants were told that their task was to work together to solve the riddles and that they would be added to a prize draw if they got them all correct. This served as a motivation to try hard at the task. All participants were entered into a prize draw regardless of performance. The number of riddles solved correctly was not taken as a performance measure as our interest was solely in the amount of nonverbal mimicry in the different conditions. Although the experiment only lasted 15 minutes,

participants were told that there was no time constraint, and that the experiment would end whenever they finished all riddles – either providing a solution or giving no response, or when they believed they had exhausted their time in the experiment. This was done to avoid participants feeling rushed and acting unnaturally. Participants were not interrupted in the 15 mins if they had not finished. The experimenter then left the room, observing progress via a one-way mirror. No controls were placed on participant's interactions; they were allowed to act freely to ensure behaviours were as natural as possible.

Once 15 minutes had past, participants were separated into different rooms and asked to complete the IOS scale, and then asked about their suspicions regarding the purpose of the experiment. No participant indicated that they thought nonverbal movement or mimicry was the purpose of the study. Each participant was then debriefed, paid £5 for taking part, and thanked for their time.

3.4 Results

3.4.1 Manipulation check

Table 3.1 shows the mean closeness and mimicry scores across the three relationship conditions. As can be seen, closeness scores were highest in the romantic partners condition, compared to the acquaintance and strangers conditions, respectively. Table 3.1 also demonstrates increased nonverbal mimicry (calculated as similarity of pose) in the romantic partners condition, compared to the acquaintance and strangers conditions, respectively

Table 3.1 *Means of closeness scores and mimicry scores according to relationship condition*

Condition	Closeness score		Mimicry score	
	M	**SD**	**M**	**SD**
Romantic partners	5.11	1.06	38.52	1.39
Acquaintances	3.39	1.26	40.69	.74
Strangers	1.82	1.06	42.59	.97

** Note: This table shows the mean mimicry scores across relationship conditions (column 4 and 5). Mimicry scores are calculated as similarity of pose; thus, a lower mimicry score indicates greater nonverbal mimicry, whilst a higher score indicates less nonverbal mimicry.

A check was carried out to ensure that reported closeness (as measured by the IOS scale) differed between the three types of relationships in the way expected. The results confirmed decreasing closeness from Romantic partners to Acquaintances to Strangers, $F(2, 129) = 93.24$, $p < .001$, $\eta_p 2 = .886$, 95%CI [4.80, 5.43]. Post hoc comparisons indicated that the mean closeness scores were higher for the Romantic partners condition compared to the Acquaintances condition ($M = 1.57$, $p < 0.001$) and the Strangers condition ($M = 3.30$, $p < 0.001$), respectively. The mean closeness scores were higher for the Acquaintances condition than the Strangers condition ($M = 1.73$, $p < 0.001$). Taken together, these results suggest that the manipulation of relationship condition was successful, and each condition significantly differed in closeness.

Figure 3.1 shows the degree of observed nonverbal mimicry as a function of closeness. The results show a significant linear trend in nonverbal mimicry, decreasing from

romantic partners to acquaintances to strangers, $F(1,63) = 159.68$, $p < 0.001$, $\eta^2 = .717$, 95% CI [0.58, 0.79]. Post hoc comparisons indicated that the mean mimicry scores were higher for the Romantic partners condition compared to the Acquaintances condition ($M = 2.17$, $p < 0.001$) and the Strangers condition ($M = 4.07$, $p < 0.001$), respectively. The mean mimicry scores were higher for the Acquaintances condition than the Strangers condition ($M = 1.90$, $p < 0.001$).

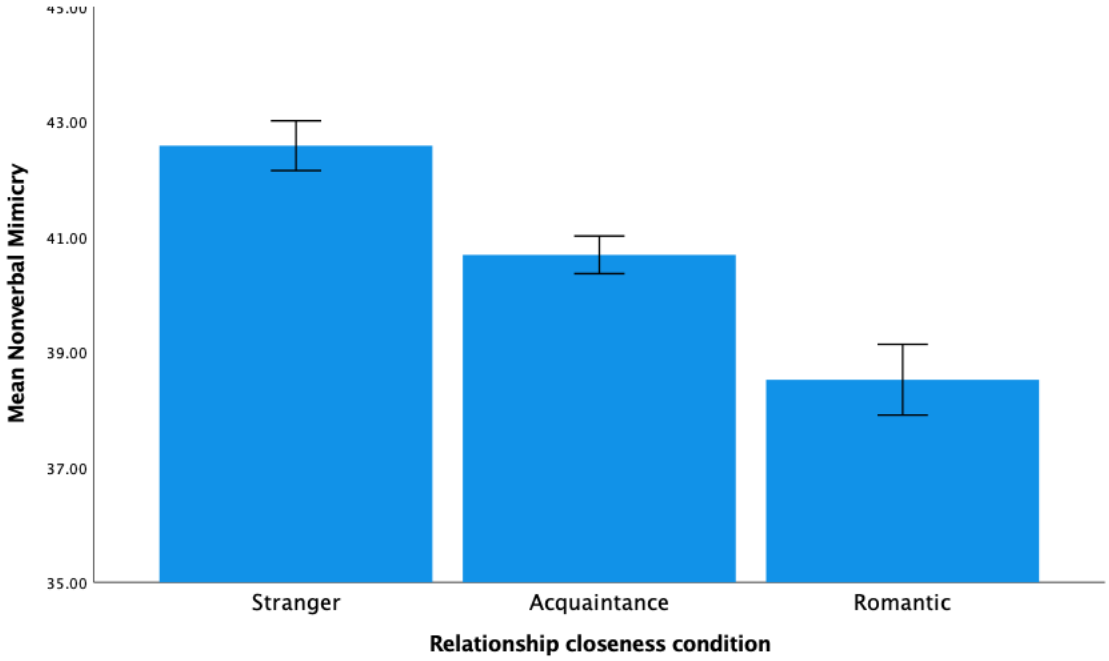


Figure 3.1 *Mean mimicry scores as a function of closeness conditions (Error bars = 95% Confidence Interval).*

3.4.2 Mimicry of discreet areas

To determine the effect of closeness on nonverbal mimicry of discreet areas, I carried out a series of one-way ANOVAs comparing mean mimicry scores for each body part across closeness conditions. There was a significant main effect for closeness condition on body (torso) movement, $F(2,63) = 20.47$, $p < .001$ partial $\eta^2 = .394$ 95%CI [.2, .53], Head, $F(2,63) = 8.40$, $p = .001$, partial $\eta^2 = .210$, 95%CI [.05, .36], right leg $F(2,63) = 10.34$ $p < 0.001$,

partial η^2 = .247, 95%CI [.07, .4], left leg, F (2,63) = 29.22 p < 0.001; partial η^2 = .481, 95%CI [.29, .60]. There was a nonsignificant effect of mimicry on the left arm F (2,63) = 2.34 p = .105, partial η^2 =.069, 95%CI [.00, .19], and right arm F (2, 63) = 1.07, p = .351, partial η^2 =.033, 95%CI [.00, .13].

Table 3.2 shows post-hoc comparisons using Bonferroni correction of mean mimicry scores across closeness conditions per body part. The results reveal no significant difference in nonverbal mimicry between romantic partners and acquaintances on any of the individual body parts other than the right leg. However, there was a significant difference in mimicry scores between the strangers and romantic partners conditions for the left leg, right leg, head, body, and upper body.

Table 3.2: *Post hoc comparisons of mean mimicry scores per body part across closeness conditions.*

Body Part	condition	Comparison condition	Mean Difference	Sig.
Left arm	Stranger	Acquaintance	.07	1.000
	Acquaintance	Romantic	.17	.422
	Romantic	Stranger	-.24	.118
Right arm	Stranger	Acquaintance	.038	1.000
	Acquaintance	Romantic	.13	.866
	Romantic	Stranger	-.16	.504
Left leg	Stranger	Acquaintance	.33	.046
	Acquaintance	Romantic	.67	< 0.001
	Romantic	Stranger	-1.00	< 0.001
Right leg	Stranger	Acquaintance	.24	.207
	Acquaintance	Romantic	.35	.029
	Romantic	Stranger	-.59	< 0.001
Head	Stranger	Acquaintance	.17	.051
	Acquaintance	Romantic	.11	.332
	Romantic	Stranger	-.29	.000
Body	Stranger	Acquaintance	.45	.000
	Acquaintance	Romantic	.17	.290
	Romantic	Stranger	-.62	.000

3.5 Discussion

The aim of Study 1 was to establish if a relationship between nonverbal mimicry and closeness exists when a more reliable measure of nonverbal movement is used. Consistent with previous research, and our hypothesis, the results showed that mimicry is related to closeness, such that mimicry is greatest in those who report stronger feelings of closeness (e.g., romantic partners) compared to those who report weaker closeness (e.g., strangers) (Chartrand & Bargh, 1999; Jefferis, van Baaren, & Chartrand, 2003). Further, the present

study is the first to consider the three levels of closeness, according to the type of relationship between participants. As such, the linear increase in mimicry according to the three closeness conditions shows a clearer relationships between NVM and closeness than if a two-condition design was used (romantic partners vs strangers).

As Study 1 was carried out using motion capture technology, it is unlikely that the results are affected by bias caused through camera positioning or manual coding. The current study also provided information on what regions of NVM are associated with closeness. This allowed us to examine the locus of NVM, something absent from prior research, where it is unclear why participants are instructed to mimic particular behaviours or body parts. The analysis found a difference between conditions in movement of the head and torso, legs, and arms. Our findings showed that NVM was greatest for both the right leg and the left leg. One possible explanation for the increased leg movement is that participants were moving back and forth toward and away from the puzzle or each other. It may also be possible that the riddle solving task induced anxiety which manifested as tapping the foot and/or shaking the leg, which was then mimicked by their interaction partner (Kendall, 1994; Wang et al., 2011). This may support the assumption that repetitive movements serve no apparent social function but instead act as 'emotional pacifiers' (Navarro & Marvin, 2008) to help calm one's nerves, possibly due to the momentary decrease in nervous tension (Hansen, Tishelman, Hawkins, & Doepke, 1990; Woods & Miltenberger, 1996).

In contrast to these effects, we found the least nonverbal mimicry in the left arm and the right arm. The task in the current experiment did not limit arm movement, so the reduced effect found is unlikely to be a result of a methodological effect. One possible explanation for the difference reported here with established finding is that participant's arm movement were being used to explain solutions to the puzzles, such that the explanatory role of the arms overtook part of the mimicry role.

Study 1 was effective at showing a link between nonverbal mimicry and closeness. However, it did not allow us to directly address the question of whether NVM leads to feelings of closeness, because closeness was predetermined by the relationship between participant dyads. Study 2 addresses this question by manipulating nonverbal mimicry and measuring the impact this had on reported closeness. In this way, we were able to measure the direct impact of NVM on feelings of closeness in dyads who have no predetermined relationship to one another.

CHAPTER FOUR:
THE MEDIATED EFFECTS OF NONVERBAL MIMICRY ON COOPERATION THROUGH CLOSENESS

Chapter 3 (Study 1) demonstrated a positive relationship between NVM and closeness. However, it was unable to show if closeness, as generated through NVM, promotes cooperation. This Chapter (Study 2) seeks to replicate Study 1 and extend the focus to consider the role of closeness as the process through which mimicry leads to cooperation. Study 2 achieves this by controlling the degree of mimicry participants experience. Specifically, the study manipulates the extent to which a person is mimicked from hard mimicry (of five behaviours) to soft mimicry (of three behaviours) to no mimicry, examining the resulting effects of this behaviour on closeness and cooperation. I measure cooperation in two ways: through an economic exchange and disclosure of personal information.

The Chapter begins with a brief introduction to cooperation (not examined directly in Study 1) and how it is measured in Study 2.

4.1 Cooperation

Although definitions vary, cooperation has been defined as working or acting together for mutual benefit. It requires two or more people to act in the best interest of their collective rather than acting for selfish benefit (Lindenfors, 2017). During task-related communication, cooperation can be expressed in terms of proposing a fair distribution of resources or equal outcomes (Cohen, Wildschut, & Insko, 2010). For example, game theory researchers have shown that during a prisoner's dilemma game, dyads who both choose to cooperation receive equal payoff (shorter jail sentence) but if both players do not cooperate, they receive punishment (longer jail time) (Cooper et al., 1996; Doebeli, & Hauert, 2005; Mulford, Jackson, & Svedsäter, 2008). Similarly, in an economic exchange game, cooperation leads to equal payoff, whilst a lack of cooperation leads to unequal payoff (DeSteno et al., 2010; Tabibnia, & Lieberman, 2007). Additionally, forensic psychology researchers have

demonstrated that cooperation can be measured in terms of information disclosure (Brimbal et al., 2019; De La Fuente Vilar et al., 2020; Vrij, Hope, & Fisher, 2014; Yang, Guyll, & Madon, 2017). For example, Alison et al. (2014) showed that during investigative interviews, cooperation is positively related to disclosure of information, and uncooperative sources avoid disclosing information when being interviewed. Likewise, disclosure of information increases as interviewees attempt to appear cooperative (Granhag et al., 2015). Thus, the practical and interpersonal benefits of increased cooperation are abundant.

Considering the clear practical and interpersonal benefits of increased cooperation, it is not surprising that, for decades, social psychology researchers have been interested in understanding factors that influence cooperation (Dawes, 1980; Deutsch, 1958; Kopelman, Weber, & Messick, 2002; Sie et al., 2014). One process that has been suggested to influence cooperation is NVM. For example, Maddux, Mullen, & Galinsky (2008) showed that confederates who mimicked the nonverbal behaviours of participants obtained better outcomes in negotiations compared to those who did not mimic the participants. Guéguen, Martin, and Meineri's (2011) participants were significantly more likely to agree to give a confederate written feedback on an essay if the confederate had engaged in NVM during a prior interaction. NVM has also been shown to increase verbal disclosure of personal information by patients during therapy (Hess, Philippot, & Blairy, 1999). Taken together, a positive relationship between NVM and cooperation is evident across the literature. In the present study, we examine the impact of nonverbal mimicry on cooperation through the process of interpersonal closeness.

4.2 Closeness and cooperation

If closeness mediates the effect of mimicry on cooperation, then a positive effect of closeness on cooperation should be evident. Consistent with this, previous research has demonstrated that a relationship exists between closeness and cooperation. For example,

Aron et al. (1997) demonstrated how increasing perceptions of closeness between participants led them to progressively disclose more information about themselves. Wiese, Kelley, Cranor, Dabbish, and Zimmerman (2011) found that self-reported closeness was a better predictor of willingness to share information than observable features such as the interaction partner's age and sex, and frequency of interaction. During criminal investigations, increasing perceptions of closeness with the suspect facilitates cooperation with the investigator (Atkinson & Butcher, 2003). Researchers have also demonstrated that cooperating with close others is associated with increased reward related activity in the brain than when cooperating with non-close others (Fareri, Chang, & Delgado, 2015). Moreover, feelings of trust and comfort towards the requester, which are important for the subject to share intimate details of their life, are only established once a close relationship has been formed (Dindia et al., 2002; Singer et al., 2001). Thus, this supports a positive effect of closeness on cooperation.

4.3 Study 2

Study 2 tested whether being mimicked a large amount (hard mimicry), a subtle amount (soft mimicry), or not being mimicked at all, affected cooperation. It then examined closeness as a mediator of this effect. Considering previous research (DeSteno et al., 2010; Granhag et al., 2015), I measured cooperation in two ways: through exchanges in an economic context and disclosure of personal information. It was hypothesised that:

Hypothesis 2: Nonverbal mimicry promotes increased cooperation during an economic exchange through feelings of closeness.

Hypothesis 3: Nonverbal mimicry promotes information disclosure through feelings of closeness.

4.4 Method

4.4.1 Participants

A power analysis based on the effect size f = 0.84 (η^2 = .717) calculated from Study 1 suggested a sampling of 18 dyads per condition would be adequate to achieve a 0.8 effect assuming an error rate of alpha = .05**.** One member of the dyadic pair was a confederate, thus we recruited 54 female university students through word-of-mouth and advertising. They had a reported mean age of 20 years (*SD* = 1.41; Range = 19 - 24). Participants were randomly allocated to either a Hard mimicry, Soft mimicry, or No mimicry condition. The confederates available to take part on the study were all female, thus, to keep the sex between dyads consistent, an all-female sample was required.

4.4.2 Materials

Closeness. Closeness was measured using the IOS measure (Aron et al., 1992), as in Study 1.

Economic exchange. We included an economic exchange game as our first measure of cooperation. Participants are informed that one person in the dyad will be a chooser (make the first choice in the exchange) and the other will be a responder (respond to player one's choice). They are then informed that they have been randomly selected to be the chooser (in reality, participants are always allocated this role). The participant is then given £2.50 and informed that they can either keep the money or transfer to their partner – the responder, but before reaching the responder, the money will be quadrupled to £10. The participant is informed that the responder then has the opportunity to send half of the £10 back to the participant. Thus, participants had the potential to double their money if they trusted the confederate. Participants were asked to choose between either Keep (not cooperate) or Transfer (cooperate). Numerous versions of economic exchange games have been used in

previous research as a behavioural measure of cooperation (Berg, Dickhaut, & McCabe, 1995; Camerer, 2003; Fetchenhauer & Dunning, 2009; Kuwabara, 2011). All participants were equally paid £5 at the end of the study.

Personal disclosure. We included disclosure of personal information as our second measure of cooperation. To measure personal information disclosure, participants were informed that it is common for individuals to want to share contact details with their fellow participant to meet after the study, and that they could tick a box if they wished for the experimenter to share their contact details. This information was provided on the bottom of the form in which participants completed the IOS scale. This task was completed in private to ensure that participants did not feel pressured to cooperate in the presence of the experimenter

Riddle task. We used the same set of riddles as used in Study 1.

4.4.3 Mimicry training.

Three confederates were trained to mimic participants to different degrees. The behaviours that showed the highest frequency of being mimicked in the previous study were used to create a list of behaviours for confederates to mimic in the present study. The specific behaviours to be mimicked were: foot tapping (slow or vigorous tapping of one foot at any one time), face touching (bringing either or both hands to the face), leg crossing (one leg being crossed in front of the other so that the knees are together and the feet are apart), stepping backwards and forwards (with relation to the wall of riddles), and posture changing (i.e., participants move from slouched with their hand on their hip to stood up straight with their hands by their sides). Collectively these nonverbal behaviours created a full body level of mimicry as they involve upper body movements, lower body movements, and posture. Three conditions were created that reflected hard mimicry (all five behaviours were copied), soft mimicry (three behaviours from the list were copied, which related to leg crossing, face

touching, and posture changing. These were chosen because they still create a full body level of mimicry, just to a lesser extent than hard mimicry), and no mimicry (confederates actively avoided mimicking any of the listed behaviours).

Videos were created for training purposes. These videos were of two individuals standing and interacting in everyday conversation. A camera was placed on the shoulder of one of the individuals facing towards the other, such that each video only captured one person. They were recorded in this was to reflect the study interaction as closely as possible. The individual talking to the camera would regularly display examples of the behaviours on the behaviour list. Each recording lasted 10 minutes. Research has shown that participants may become suspicious that they are being mimicked when confederates engage in mimicry after too short time delays (i.e., 1 second after showing the behaviour is displayed) but that mimicry needs to occur within 10 seconds of it being displayed to have its effect (Bailenson, Beall, Loomis, Blascovich, & Turk, 2004; Stel, Van Dijk, & Olivier, 2009). Thus, confederates mimicked behaviours 5-10 seconds after the participant had displayed them.

Three female confederates were trained in all three mimicry conditions. Training sessions were recorded and run by the experimenter. These recordings were analysed against the training videos used, to assess the confederate's ability to detect and mimic the correct behaviours in the appropriate time window. For each condition, training continued until 90% accuracy of mimicry (or no mimicry) was achieved. Five different training videos were used. Both the training videos and the confederate training procedures were entirely novel methods of nonverbal mimicry training. Following this, a mock run of the study was recorded and coded by the experimenter. Mimicry of additional behaviours that were not on the behaviour list was coded as inaccurate mimicry. If 90% accuracy was achieved, the study was ready to begin. If 90% accuracy was not reached, training continued. A total of 24 hours of training was given to each confederate, including 2 mock runs for each confederate.

4.4.4 Manipulation check

As a further test of the confederates' mimicking, 15 participants at the start of the testing session and 15 participants at the midpoint of testing interacted with the confederate while both wore an Xsens suit. These data were examined across the three condition of mimicry. Mimicry scores are calculated as similarity of pose; thus, a lower mean mimicry score indicates greater nonverbal mimicry, whilst a higher mean mimicry score indicates less nonverbal mimicry. The results showed that there was a linear decrease in mimicry from the hard mimicry condition (M = 37.5, SD = 2.22) to the soft mimicry condition (M = 41.85, SD = 1.09) and the no mimicry condition (M = 43.4, SD = 1.84); $F(2, 14) = 14.56$, $p < .001$ $\eta 2 = .708$, 95% CI [.26, .82]. Based on this, the main testing period took place without the use of the Xsens suits in which 18 interactions took place in each condition (hard mimicry, soft mimicry, and no mimicry). The same was true of the midpoint check. The results showed that there was a linear decrease in mimicry from the hard mimicry condition (M = 36.73, SD= 2.28) to the soft mimicry condition (M = 39.88, SD = 2.22) and the no mimicry condition (M = 42.9, SD = 1.42); $F(2, 14) = 14.56$, $p < .001$ $\eta 2 = .662$, 95% CI [.19, .79].

4.4.5 Procedure

The study procedure was identical to Study 1, but for the interaction partner being an undisclosed confederate. During the riddle task, the confederates contributed equally across each interaction and were encouraged to be helpful in guiding the participants to the correct answers without raising suspicion of their involvement in the study. During this interaction, the confederate either engaged in hard mimicry, soft mimicry, or avoided mimicking any of the participant's nonverbal behaviours from the behaviour list. Each confederate took part in each condition of mimicry to an equal extent.

Following the riddle solving task, the confederate and participant were separated, and the participant was asked to complete the IOS scale and the economic exchange game. In reality, only the participant completed these scales. Finally, to measure personal information disclosure, participants were informed that it is common for individuals to want to share contact details with their fellow participant to meet after the study, and that they could tick a box if they wished for the experimenter to share their contact details. No participants reported suspicion that they were being mimicked. Each participant was fully debriefed, paid £5 for taking part, and thanked for their help.

4.5 Results

4.5.1 Hypothesis Testing

Table 4.1 shows the mean closeness and cooperation scores across the three mimicry conditions. As can be seen, closeness and cooperation scores were highest in the hard mimicry condition, compared to the soft mimicry and no mimicry conditions, respectively.

Table 4.1 *Means of closeness scores and cooperation according to mimicry condition*

Condition	Closeness score		Number of participants who cooperated (Economic exchange)		Number of participants who disclosed information	
	M	**SD**	**N**	**%**	**N**	**%**
Hard Mimicry	4.70	.63	14	78	12	67
Soft Mimicry	3.70	.70	10	56	7	39
No Mimicry	2.00	.62	4	22	3	17

** Note: This table shows the mean and standard deviations for closeness scores across mimicry conditions (column 2). Cooperation was measured as a dichotomous measure of either cooperate or not cooperate, this table shows the number of participants who cooperated (column 3 and 4).

To test the predictions that closeness mediates the relationship between NVM and the two cooperation measures, we used the PROCESS macro (Hayes, 2017) and tested the significance of the indirect effect using bootstrapped (n = 10,000) confidence intervals.

The path (direct effect) from mimicry to closeness was statistically significant (*b* = 1.47, *SE* = .11, *p*< 0.001) 95% CI [1.25, 1.68]. The path (direct effect) from mimicry to economic exchange was nonsignificant (*b* = 1.02, *SE* = .81, *p* = .207) 95% CI [-.57, 2.61]. The path (direct effect) from closeness to economic exchange was nonsignificant (b = .16, *SE* = .34, *p* = .746) 95% CI [-.80, 1.11]. The bootstrapped indirect effect (*IE* = .233) of mimicry on economic exchange mediated by closeness was nonsignificant: 95% CI [-1.68, 2.29].

The path (direct effect) from mimicry to economic exchange was nonsignificant (b= -.33, *SE* = .78, *p* = .676) 95% CI [-1.85, 1.20]. The path (direct effect) from closeness to sharing information was nonsignificant (*b* = -.55, *SE* = .49, *p* = .268) 95% CI [-1.51, .42]. The bootstrapped indirect effect (*IE* = -.804) of mimicry on economic exchange mediated by closeness was nonsignificant: 95% CI [-3.19, .82].

4.6 Discussion

Study 2 sought to address the question of how NVM leads to cooperation, by examining the mediating role of closeness. Our findings were inconsistent with our hypothesis and showed that there was a nonsignificant effect of NVM on both cooperation during an economic exchange and information disclosure. Such that, an increase in NVM did not lead to an increase in either form of cooperation. This lack of a significant finding in the direct effect of NVM on cooperation is somewhat surprising given the strong association between NVM and cooperation shown in previous research (Haidt et al., 2008; Maddux et al., 2008; McNeill, 1995).

Further, a nonsignificant effect of closeness on cooperation during economic exchange was also evident. This is also surprising given that behavioural economic researchers (DeSteno et al., 2010; Frank, 1988) and biologists (Trivers, 1991) have argued that economic cooperation is socially adaptive, and affective states and sentiments towards the other may foster it. As such it would makes sense that feelings of closeness towards one's interaction partner would facilitate economic cooperation. Similarly, increased closeness did not lead to a significant increase in information disclosure, this is contradictory to previous research which has shown that increasing perceptions of closeness between participants leads participants to progressively disclose more information about themselves (Aron, Melinat, Aron, Vallone, & Bator, 1997).

However, our findings did show a significant relationship between NVM and closeness. Thus, these findings build on that of study 1, by demonstrating that varying degrees of NVM leads to increased feelings of closeness in varying degrees in individuals who had no predetermined relationship to one another. Such that, a high amount of NVM (hard mimicry) increased closeness to a greater degree than a lesser degree of mimicry (soft mimicry) and no mimicry, respectively. This finding that an increase in NVM leads to a significant increase in closeness is somewhat consistent with the "social glue" hypothesis, which suggests that mimicry may help bind people together and facilitate harmonious interpersonal interactions (Hale & Antonia, 2016; Lakin, & Chartrand, 2003; van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Our findings suggest that one way in which mimicry works to do this is through closeness. However, given that previous research has shown a strong association between NVM and cooperation (Haidt et al., 2008; Maddux et al., 2008; McNeill, 1995), as well as between closeness and cooperation (Aron, Melinat, Aron, Vallone, & Bator, 1997; Slatcher et al., 2010; Wiese, Kelley, Cranor, Dabbish, &

Zimmerman, 2011), the nonsignificant findings in study 2 may be due to a methodological concern.

A possible explanation for the nonsignificant effects found in study 2 may be due to measures of cooperation being binary and involved participants being given the option to cooperate or not cooperate. In the economic exchange game participants either transferred all the money to the confederate or they transferred none of the money, likewise, participants had the option of disclosing personal details or not disclosing personal details. As such, it was not possible to examine how mimicry affected cooperation during the economic exchange, or the degree of information disclosure. Thus, it was not possible to examine how the degree of increase closeness effected the degree of cooperation for the same reason. Consistent with this, previous research demonstrating a direct link between nonverbal mimicry and cooperation has used a continuous measure of the latter. For example, measuring cooperation as the total number of points obtained during a negotiation (Maddux et al. 2008). Likewise, previous research demonstrating a direct link between closeness and cooperation measured the progressive increase in cooperation as a function of increasing closeness (Aron, Melinat, Aron, Vallone, & Bator, 1997).

This could offer a potential explanation as to why I found a non-significant direct effect of NVM on cooperation. As such, it is important that the degree of cooperation is examined as a function of the degree of increase in NVM. This limitation was addressed in Study 3 by examining how NVM influences the degree of cooperation when measuring on a continuous scale.

CHAPTER FIVE:
USING NONVERBAL MIMICRY TO INCREASE INFORMATION DISCLOSURE, THROUGH THE PROCESS OF CLOSNEESS

Previous research has argued that nonverbal mimicry increases cooperation and leads to better outcomes during negotiations (Maddux et al., 2008). In this Study, as well as controlling for the dichotomous measure of cooperation limitation of Study 2, nonverbal mimicry is implemented within an investigative interview scenario to examine if it increases disclosure of information (Atkinson et al., 2003; Slatcher, 2010; Wiese, Kelley, Cranor, Dabbish, & Zimmerman, 2011). Specifically, Study 3 examined the degree of information disclosure when exposed to varying degrees of mimicry from hard through soft to none, where information disclosure was amount of information revealed. Although this study was originally intended to be carried out in-person, due to social distancing and national lockdown restrictions, this study was carried out virtually over Microsoft teams. Previous research has shown that positive effects of mimicry can be obtained via virtual interactions (Bailenson & Yee, 2005; Maurer & Tindall, 1983), giving some assurance that the same processes would operate virtually as they do physically.

5.1 Investigative interviews and nonverbal mimicry

The core objective of investigative interviews is to elicit as much reliable and verifiable information as possible (Fisher, 2010). There are two main approaches to elicit information during investigative interviews, Accusatory approaches and Information gathering approaches. Empirical research has demonstrated that the ability to influence cooperation between suspect and investigator is crucial to the success of investigative interviews (Brimbal, Dianiska, Swanner, & Meissner, 2019). Hence, information gathering approaches, which focus on influencing cooperation and a “working alliance” with the interviewee, are evidenced to be effective at increasing the amount and accuracy of

information gathered (Brimbal, Dianiska, Swanner, & Meissner, 2019). Likewise, information gathering approaches increase the likelihood of true confessions and minimising false confessions compared to accusatory approaches (Evans et al., 2013; Granhag, 2010; Vanderhallen & Vervaeke, 2014). Considering that NVM has been associated with a positive increase in cooperation (Boone & Buck, 2003; Stel & Vonk, 2010), information gathering approaches may benefit from the inclusion of NVM. For example, increased NVM leads to investigators obtaining better outcomes during negotiations (Maddux et al., 2008; Swaab, Maddux, & Sinaceur, 2011). In a study by Jacob et al. (2011), four retail staff members either mimicked or did not mimic the nonverbal behaviours of customers they interacted with in the store. Findings showed that customers who had been mimicked were significantly more likely to buy an item that the retail staff member had suggested than customers who had not been mimicked. Additionally, NVM has also been shown to increase pro-social behaviour, which would be of great benefit during investigative interviews (Shaw et al., 2015). For example, in a study by Van Baaren, Holland, Kawakami, and Van Knippenberg (2004), participant and confederate dyads engaged in a short interaction together in which confederates either engaged in NVM or did not engage in NVM. Following this task, the experimenter "accidentally" dropped some pens on the floor when walking past the participant. Participants who had been mimicked in the prior interaction were significantly more likely to help the experimenter pick up the pens. Thus, the positive social consequences of NVM are well-established (Hess, Philippot, & Blairy, 1999). The current study examines the impact of nonverbal mimicry on cooperation in the context of an investigative interview.

5.2 Study 3

Study 3 sought to address the limitations of Study 2 by this time quantifying disclosure rather than using a dichotomous measure. As in Study 2, participants were exposed to mimicry in varying degrees; a large amount (hard mimicry), a subtle amount (soft

mimicry), or not being mimicked at all. Considering that cooperation can be measured in terms of information disclosure (Brimbal, Dianiska, Swanner, & Meissner, 2019; Moser & Wodzicki, 2007), I measured cooperation as the amount of information units shared during a forensic interview task. It was hypothesised that:

Hypothesis 4: There will be a linear increase in information units disclosed across these three groups that correlates positively with increased mimicry, and that this effect will be mediated by closeness.

5.3 Method

5.3.1 Participants

A power analysis based on the effect size f = .88 calculated from Study 2 suggested a sampling of 54 dyads (18 per condition) would be adequate to achieve a 0.8 effect assuming an error rate of alpha = .05. As the three confederates from study 2 were retained, all participants were female, comprising 35 university students and 19 non-students, who were recruited through word-of-mouth and advertising. Participants were randomly allocated to the three conditions of Hard mimicry, Soft mimicry, or No mimicry. Participants reported a mean age of 21 years (SD = 1.45; Range 19-24).

5.3.2 Materials

Closeness. Closeness was measured using a single item: "I feel close to my fellow participant", which is known to reflect the IOS scale proposed by Aron et al. (1992). To disguise the purpose of the study, and hence the decision to move away from the pictorial measure of closeness as used in Studies 1 and 2, the single item featured in a list of 10 items with the other 9 items asking about non-related factors such as x and y. An example of these

questions is "I enjoyed the careful planning at each stage". All items were responded to on a 7-point likert scale that ranged from completely disagree (1) to completely agree (7).

Riddle task. I used the same set of riddles as used in Study 1 and Study 2.

5.3.3 Procedure

Training of nonverbal mimicry.

Due to the study being conducted online, the behaviour list from Study 2 was adapted to include only upper body mimicry. Three female confederates already trained in nonverbal mimicry from study 2 were re-trained to carry out nonverbal mimicry effectively online. Confederates were given a set of nonverbal behaviours, as with Study 2, they then practised mimicking the nonverbal behaviours of persons observed on video recordings. Due to the study being conducted online, only upper body mimicry was possible, thus the full upper body of the experimenter was visible. The specific behaviours to be mimicked were face touching, shrugging shoulders, leaning forwards or backwards, nodding head, and posture changing. Hard mimicry involved mimicking all these behaviours. Soft mimicry involved mimicking some of these behaviours: leaning forwards or backwards, nodding head, and posture changing. No mimicry involved not mimicking any of these behaviours.

As with Study 2, videos were created for training purposes. Video recordings were of the experimenter speaking to the camera while sat at a desk to mirror typical conditions of an online meeting. Confederates practised nonverbal mimicry on video recordings of two other individuals in identical conditions. The training was given for each mimicry condition (Hard mimicry, Soft mimicry, No mimicry). Mock trials of the study were run and recorded once the confederate felt comfortable in their ability to mimic correctly in each condition. A mock run of the study was recorded for each condition and coded by the experimenter; 90% accuracy used as a marker of success. Mimicry of additional behaviours that were not on the

behaviour list was coded as inaccurate mimicry. Once confederates had achieved 90% accuracy, testing commenced. A total of 15 hours of re-training was given to each confederate.

Experimental task.

This study was carried out online using Microsoft teams, due to social distancing and national lockdown restrictions. Participants were told that the study was investigating how the effects of puzzle-solving tasks on decision-making. They were sent an information sheet and provided their consent via an online consent form. A date and time for the study to take place was then agreed. Participants were invited into an online meeting with a confederate who they believe to be a fellow participant. Participants and confederates were sat with their upper body visible to reflect a natural professional context. Both parties were then sent the same list of 9 riddles and given 10 minutes to work together to solve as many as possible; they were told that they did not have to write their answers down and just needed to discuss with each other verbally. During this interaction, the confederate either engaged in hard mimicry, soft mimicry, or avoided mimicking any of the participant's nonverbal behaviours from the behaviour list. During the interaction, the experimenter's microphone and camera were turned off. However, participants were told that the experimenter was observing to ensure the task was carried out properly.

After 10 minutes had passed, the experimenter re-joined the interaction to ask how they did and reveal the correct answers. Participants were then asked to turn off their microphone and camera, complete a questionnaire sent to them containing ten questions and re-join the meeting when complete to discuss the final stage of the experiment. This usually took around 5 minutes.

The final stage of the experiment involved a mock interrogation. Participants were told they would be playing the source, and the confederate would be the interrogator. To

avoid suspicion, participants were told that the computer had randomly selected them to be the source. Participants were then sent the instructions and information sheet via email and the virtual meeting was ended to allow them to read over this information. After 15 minutes has lapsed, the experimenter invited the participant into another meeting with the confederate. The information given to participants concerned an extremist group planning another terror attack; the information they were given was the only information they knew about the attack; however, they were aware that this information was incomplete. As in the original study of Oleszkiewicz, Granhag, and Cancino Montecinos (2014), participants had to strike a balance between providing enough information to assist the police and appear cooperative enough to be granted free conduct out of the country, without providing too much that it seems they were involved in instigating the attacks and had strong social ties with the group. Participants were asked not to fabricate any information but not advised on any other forms of lying. This is important because successfully striking a balance between not giving away too much or too little, participants would have to consciously withhold information, which is one form of lying (Vrij, 2008). As an incentive to motivate participants, they were told that their compensation for their involvement in this task would be between £5-£15, depending on how well they strike this balance. Participants were told that those who were able to balance providing enough but not too much information would receive closer to £15, whilst those who provided too much or too little information would receive closer to £5. All participants were paid £10.

When participants were ready, they were invited back into the group meeting for the interrogation task. During the task, they were asked pre-set questions by the confederate (see Table 5.1). As with the first task, the experimenter had their microphone and camera turned off. This task was audio recorded to enable later coding against a checklist of information units that indicated the level of cooperation on the activity.

Source Information. This contained information on an extremist group planning another terror attack, including details of previous attacks. The information was presented in the form of a coherent story. Participants were asked to imagine that this information was all the information they held regarding the attack. There was a total of 35 separate pieces of information provided, all information units were factual, for example "You also know that the plan is to plant the bomb during daytime". Participants were not informed of how the story they were given would be broken down into exact information units. This methodology, including the measure of information units and information sheet given to participants, was taken from (Oleszkiewicz, Granhag, & Cancino Montecinos, 2014), who investigated eliciting intelligence from human sources.

Questions for interrogation task. These questions used a combination of open and explicit questions while avoiding leading questions. as detailed in Table 5.1. Questions and order of questions were identical across all conditions.

Table 5.1 *Questions used by the confederate for the interrogation task.*

As you surely can understand, I am very interested in what you have to tell me about the upcoming Attack. So, how about you simply tell me what you know?
Okay, is there anything else you'd like to add?
Okay—- thank you very much—-then I have some questions I would like you to answer.
Where will they attack?
Is there anything else we should know about this?
Will the bomb explode after the stores have closed?
Is there anything else you can tell us?

After completing the study, participants were asked about their suspicions regarding the purpose of the experiment. No participants indicated that they thought nonverbal movement or mimicry was the purpose of the study or that their interaction partner was a confederate. Each participant was then debriefed, paid for taking part, and thanked for their help.

5.4 Results

5.4.1 Manipulation Check

A manipulation check was carried out to ensure that the three conditions differed significantly in closeness. A one-way ANOVA comparing closeness scores across conditions (hard mimicry vs. soft mimicry vs. no mimicry) revealed a statistically significant trend, $F(2, 51) = 68.99$, $p < 0.001$, $\eta^2 = .730$, 95% CI [.582, .800]. Those in the hard mimicry condition reported greater feelings of closeness towards their interaction partner than those in the soft mimicry condition ($M = 1.28$, $p < 0.001$) and the no mimicry condition ($M = 2.443$, $p < 0.001$). Those in the soft mimicry condition reported greater feelings of closeness towards their interaction partner than those in the no mimicry condition ($M = 1.17$, $p < 0.001$).

5.4.2 Hypothesis Testing

Table 5.2 shows the mean closeness and cooperation scores across the three mimicry conditions. As can be seen, closeness and cooperation scores were highest in the hard mimicry condition, followed by the soft mimicry condition, and the no mimicry condition, respectively.

Table 5.2 *Mean closeness and cooperation scores according to mimicry condition*

Condition	Closeness score		Cooperation (Information Units)	
	M	*SD*	*M*	*SD*
Hard Mimicry	5.28	.75	27.67	1.5
Soft Mimicry	4.11	.47	23.06	2.21
No Mimicry	2.83	.62	16.72	1.45

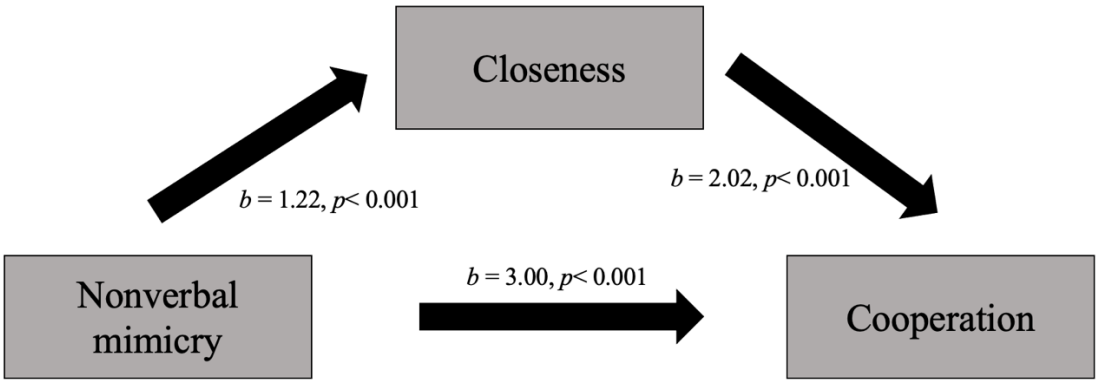
** Note: This table shows the mean and standard deviations for closeness scores and cooperation scores across mimicry conditions (column 2 and 4). Cooperation was measured as how many information units were disclosed (column 4).

There was a significant linear trend in information units disclosed as a function of nonverbal mimicry, F (2, 51) = 177.04, $p < 0.001$, $\eta^2 = .730$, 95% CI [.582, .800]. Those in the hard mimicry condition disclosed more information units than those in the soft mimicry condition, and the no mimicry condition. As shown in Table 5.2, post hoc comparisons indicated that the number of information units shared were higher for the hard mimicry condition compared to the soft mimicry condition ($M = 6.33$, $p < 0.001$) and the no mimicry condition ($M = 10.94$, $p < 0.001$), respectively. The number of units disclosed were higher for the soft mimicry condition than no mimicry condition ($M = 4.61$, $p < 0.001$).

To test the prediction that closeness mediates the relationship between mimicry and information units disclosed, the PROCESS macro (Hayes, 2017) was again used with the significance of the indirect effect tested using bootstrapped 95% confidence intervals. Figure 1 shows the path (direct effect) from mimicry to closeness was statistically significant ($b =$

1.22, *SE* = .10, *p*< 0.001) 95% CI [2.17, 3.83], as was the path (direct effect) from mimicry to information units (*b* = 3.00, *SE* = .10, *p*< 0.001) 95% CI [1.02, 1.43], and the path (direct effect) from closeness to information units (*b* = 2.02, *SE* = .29, *p*< 0.001) 95% CI [1.44, 2.60]. The bootstrapped indirect effect (*IE* = 2.472) of mimicry on information units mediated by closeness was statistically significant: 95% CI [1.88, 3.17].

Figure 5.1 *The effect of nonverbal mimicry on cooperation, mediated by closeness*



** Note: This figure shows the direct effect of nonverbal mimicry on increased cooperation as well as the indirect effect of mimicry on increased cooperation through the process of closeness.

5.5 Discussion

Consistent with the hypothesis, Study 3 showed that nonverbal mimicry during interpersonal interactions increases willingness to disclose information with the mimicker, compared to not engaging in nonverbal mimicry. There was a linear increase in the number of units disclosed according to mimicry condition, participants disclosed a greater number of information units in the Hard mimicry condition compared to the Soft mimicry and the no mimicry condition respectively. This is an important finding because research has shown that higher levels of cooperation lead to more prosocial outcomes compared to lower levels of

cooperation (Oleszkiewicz, Granhag, & Cancino Montecinos, 2014). Additionally, given that the main objective of investigative interviewing is to gather as much information from a source as possible (Fisher, 2010), our findings suggest that information gathering approaches may benefit from the inclusion of nonverbal mimicry.

Additionally, findings from Study 2 showed that the direct effect of NVM on cooperation was non-significant. Study 3 used a more sophisticated measure of cooperation, allowing us to examine the degree of increase in cooperation according to the increase in NVM. Given that the direct effect of cooperation in Study 3 was significant, which is consistent with previous research (Haidt et al., 2008; Maddux et al., 2008; McNeill, 1995), the non-significant result observed in Study 2 was likely due to cooperation being measured using a using a dichotomous measure. Additionally, in the current work, the same questions were asked in all conditions, consisting of a standardised set of open and explicit questions, thus the significant increase in information disclosure observed in the mimicry conditions compared to the no mimicry condition demonstrates the ability of mimicry to facilitate increased cooperation. This is in line with previous literature, suggesting that NVM is a cooperation-enhancing mechanism (Haidt et al., 2008, McNeill, 1995, Shaw et al., 2015; Swaab, Maddux, & Sinaceur, 2011).

As predicted, the effects of mimicry on information disclosure were mediated by interpersonal closeness. Such that, the degree of increase in information disclosure as a result of NVM was mediated by the degree of increased closeness. These results build on existing evidence of Chartrand and Bargh (1999), who argue that mimicry has evolved to serve a "social glue" function, through its adaptive ability to help bind people together and facilitate harmonious interpersonal interactions, by demonstrating that one way in which it does this is

through closeness. As such, our results provide new insight into the relationship between nonverbal mimicry and cooperation, by demonstrating the important role of closeness. Moreover, the positive relationship between increased NVM and increased closeness observed in Study 3 is consistent with that of Study 1 and Study 2. Given that Study 3 was carried out virtually. Our findings are also consistent with previous research that face-to-face interactions is not necessary for NVM to be effective during dyadic interactions (Bailenson & Yee, 2005; Maurer & Tindall, 1983). This is particularly important finding following the Covid-19 pandemic which restrict face-to-face interactions from taking place, meaning that virtual communication may be the only alternative.

In sum, the current study demonstrates that NVM can be used to increase increases information disclosure of a source, and it does this through the process of closeness. However, the current study can only speak for the effects of mimicry within the dyad, future research should aim to extend this understanding by examining whether the effects of mimicry, when observed from a third-party perspective, work through the same process as mimicry within the dyad

CHAPTER SIX:
THIRD-PARTY JUDGMENTS OF CLOSNESS AND COOPERATION BASED ON OBSERVATIONS OF MIMICRY

Research has shown that affiliation signals, such as nonverbal mimicry (NVM), are used to navigate the social world and guide our interactions, even when they are not directed towards us (Kavanagh, Suhler, Churchland, & Winkielman; 2011; Semin & Cacioppo, 2008). Observations of NVM among interacting parties are associated with perceptions of rapport (Grahe & Bernieri, 1999), trustworthiness (Kavanagh et al., 2013), and can be used to infer power differentials (Over & Carpenter, 2014). When looking to explain how mimicry between interaction partners shapes behaviour, research has identified the importance of interpersonal closeness (Lakin, Jefferis, Cheng & Chartrand, 2003; Van Baaren, Holland, Karremans, & Van Knippenberg, 2003). The studies reported in Chapter 3 through 5 offered empirical support for the role of closeness as one of the psychological processes through which mimicry works to increase cooperation. The current study aims to extend this understanding to examine whether the effects of NVM between an interacting dyad on the observer's behaviour, work through the same process as mimicry within the dyad. This study also goes a step further and examines the role of two types of closeness: situational (feelings of closeness towards another at a particular point in time) and dispositional (feelings of closeness to others in general, also referred to as self-construal) on judgments of cooperation.

It is important to understand how social judgements are formed by an observer, as judgments towards unfamiliar individuals influence attitudes and subsequent behaviours toward those individuals (Rosnay, Cooper, Tsigaras, & Murray, 2006; Skinner, Meltzoff, & Olson, 2017). In this study I had three aims. First, to examine whether third-party observations of NVM affect judgments of cooperation towards an interacting dyad and test if the effects of these judgments are mediated by feelings of closeness towards the interacting dyad. Willingness to engage in conversation was used as a measure of cooperation. Second,

to examine whether feelings of closeness to others in general moderates the effect of NVM on judgments of cooperation. Third, to test if feelings of closeness towards others in general determines accuracy of judgments about the relationship status of the interacting dyads. Findings from the current study are important because, understanding the antecedents of cooperation means that those aiming to influence cooperation, of a third-party, can design effective strategies. Additionally, our research contributes to the social judgement literature by examining the processes behind judgement accuracy.

Heider et al. (1958) argued that understanding and predicting the behaviours of others is one of the most fundamental problems our species face. Thus, the ability to form sophisticated social judgements is an important evolutionary achievement (Williams, von Hippel, & Forgas, 2003). Human beings make quick and automatic inferences about others all the time, even before any interaction with them has taken place (Vrticka, Andersson, Sander, & Vuilleumier, 2009). Social perception, which is in part the ability to decode another person's mental states based on basic behavioural signals, is automatic and highly efficient (Bargh, Chen, & Burrows, 1996; Christensen & Rosenthal, 1982; Cronshaw & Lord, 1987; Shariff & Tracy, 2009; Stapel & Blanton, 2004), and typically precedes more effortful and explicit processes (Carpenter et al., 1998; Low & Perner, 2012). For example, Tuk, Verlegh, Smidts, and Wigboldus, (2009) found that people form fast and automatic impressions of others based on their facial expressions. Foulsham et al. (2010) showed that we use the available social cues of others to infer their intentions and guide our own behaviour. Further, in social and psychological disorders such as autism spectrum disorder and schizophrenia, the ability to use social cues is typically impaired, resulting in difficulty regulating social interactions (Klin et al., 2002; Lee et al., 2018). Thus, social judgments are an important part of social interactions, and research shows that the judgments we make

about individuals affect our later interactions and behaviours towards them. For example, children who observed interactions in which one individual displayed nonverbal cues indicative of warmth and friendliness towards their interaction partner developed more positive attitudes toward that individual, compared to those who displayed cold and hostile nonverbal cues (Skinner et al., 2017). Likewise, voters who regularly watched a newscaster who showed more positive facial expressions when talking about one of the candidates were significantly more likely to vote for that candidate compared to other candidates (Mullen et al., 1986).

Social judgements formed from observations of others can have a high level of accuracy even when based of brief interactions (Albright et al, 1988; Funder & Colvin, 1988). Funder and Colvin (1988) showed participants 5-min videotaped clips of targets and found that personality ratings by strangers correlated significantly with the self-ratings of targets. Other research has supported judgement accuracy based on minimal cognitive processing, suggesting that judgments are often more accurate when individuals rely on their intuition rather than when they introspect or reason (Wilson & Schooler, 1991).

The ecological theory of person perception assumes that our perceptual abilities are shaped by their ecological utility (McArthur & Baron, 1983; Zebrowitz & Collins, 1997). Thus, we are more likely to recognise cues related to adaptive actions (Erdelyi, 1974; Fink & Penton-Voak, 2002). As such, it would make sense that those who intend to interact with a target would be more likely to recognise affiliation cues of a target than those who do not intend to interact with the target. In line with this, research examining personality judgements has supported that judgment accuracy depends on the utilisation of cues and has shown self-serving differences in the recognition of behavioural cues between interactants and observers (Back & Nestler, 2016; Wall, Taylor, & Campbell, 2016). Simply put, the same number of cues are available to both observes and interactants but observes who do not intend to interact

with a target are less concerned with their interpersonal traits, thus cues communicating the interpersonal nature of the trait may be less salient. This suggests that even when a range of relevant cues are available, accurate judgments will only be formed if the observer recognises and uses these cues in their assessments of a target (Funder et al., 1995, 1999).

6.1 Nonverbal mimicry and social judgements

A powerful social signal that has been shown to guide social judgments is NVM (Kavanagh, Suhler, Churchland, & Winkielman, 2011). NVM can be defined as a behaviour that a person copies from a conversational partner while they interact (Kastendieck, Mauersberger, Blaison, Ghalib, & Hess, 2020), thus, NVM is often deemed the "Chameleon effect" (Chartrand & Bargh, 1999). NVM typically occurs without conscious awareness (Bavelas, Black, Lemery, & Mullett, 1986; Chartrand & Bargh, 1999), however research has shown that NVM can be used strategically as a tool to gain social advantage (Bailenson & Yee, 2005; Maddux, Mullen, & Galinsky, 2008). Indeed, research on dyadic NVM has shown that nonverbal mimicry has the power to influence social judgment and behaviour toward the mimicker (Bailenson & Yee, 2005; Chartrand & Bargh, 1999; Maurer & Tindall, 1983).

A vast amount of research has been dedicated to studying the effects of NVM within dyads (Hess, Philippot, & Blairy, 1999; Maddux et al., 2008; Swaab, Maddux, & Sinaceur, 2011; Valdesolo, Ouyang, & DeSteno, 2010). However, less research has examined third-party judgements made on the basis of MVN. Capozzi, Becchio, Willemse, and Bayliss (2016) demonstrated that third-party observers direct greater attention to individuals who follow the gaze of their interaction partner. Kavanagh, Suhler, Churchland, and Winkielman (2011) showed that third-party observations of mimicry influence observer's judgments of the mimicker. Participants watched videos of one-on-one interviews, in which the interviewee either mimicked or did not mimic the interviewer's gestures. In this experiment,

interviewers were either cordial or rude to the interviewee. Results showed that participants judged interviewees as more competent when they mimicked cordial interviewers and less competent when they mimicked rude interviewers. Thus, this shows that the effects of NVM between a dyad on an observer's judgments are moderated by its appropriateness (Kavanagh et al., 2011). Although research shows that third-party observations of mimicry influence social judgments, this field is limited to a few studies. Within this body of work, it is not clear how mimicry works to influence social judgements, and indeed if third-party observations of mimicry impact an observers' willingness to cooperate.

Furthermore, the increased use of communication platforms such as Zoom, Microsoft Teams, and Skype etc. has vastly reduced the need for in-person interactions. This is particularly relevant following the Covid-19 pandemic which prevented face-to-face meetings from taking place. Hence, it is important to understand how NVM works in this context. Although previous research has explored third-party judgments of mimicry from observations of video interactions, the interactions themselves typically took place in person (Kavanagh, Suhler, Churchland & Winkielman, 2011). During virtual group interactions, all individuals are likely to be interacting via an online platform, rather than just the observer. Thus, participants in the current study will observe interactions in which all individuals are communicating over Microsoft Teams to reflect a real virtual group meeting/ virtual party as close as possible.

6.2 Situational closeness

One process through which mimicry is proposed to shape an interactant's behaviour is closeness (Ashton–James, Van Baaren, Chartrand, Decety, & Karremans, 2007; Gueguen, Jacob, & Martin, 2009; Van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009; Van Swol, & Drury-Grogan, 2017). Research shows that we are more likely to trust, share personal

information with, and cooperate with those we feel closer to (Slatcher, 2010; Wiese, Kelley, Cranor, Dabbish, & Zimmerman, 2011). For example, generating increased perceptions of closeness between participants causes them to progressively disclose more information about themselves (Aron, Melinat, Aron, Vallone, & Bator, 1997). Studies have also shown that NVM generates feelings of closeness (Van Baaren, Holland, Steenaert, & Van Knippenberg, 2003). For example, in a study by Van Baaren, Holland, Karremans, and Van Knippenberg (2003), participants interacted with the experimenter whilst the experimenter either mimicked or avoided mimicking the posture and behavioural mannerisms of the participant. Results showed that feelings of closeness were significantly higher in participants who had been mimicked compared to those who had not been mimicked. Likewise, Chartrand and Bargh (1999) showed that participants who were mimicked by a confederate reported greater feelings of closeness towards the confederate compared to those who were not mimicked. Stel and Vonk (2010) demonstrated that engaging in NVM during dyadic interactions leads to both the mimicker and mimikee reporting greater feelings of closeness to one another compared to if they had not engaged in NVM. Moreover, research examining the effects of mimicry through closeness have only focused on mimicry within the dyad, and it is unclear whether thus effect will transfer to third-parties. That is, does observing mimicry in a dyad lead to increased closeness towards the dyad and thus increased positive judgements towards the dyad? This chapter seeks to examine whether third-party observations of mimicry effects an observer's judgement of cooperation towards an interacting dyad, and whether feelings of closeness towards the interacting dyad mediates this effect.

6.3 Dispositional closeness

Additionally, this chapter examines the role of participant's self-construal on the relationship between observed mimicry and willingness to engage in conversation with an interacting dyad, as well as its effects on judgment accuracy regarding the relationship

between the interacting dyad. Self–construal can be defined in terms of interconnectedness of the self with others (Brewer & Gardner, 1996), thus it can be measured as feelings of closeness towards others in general (Aron & Aron, 1986). Individuals with an independent self-construal are more likely to view themselves, including their beliefs, goals, traits, and experiences, as more separate from others compared to those with an interdependent self-construal. Individuals with an interdependent self-construal are more likely to define themselves with reference to their social relationships and group memberships (Markus & Kitayama, 2001, 2003). Researchers examining the social consequences of one's self-construal have shown that individuals with an interdependent self–construal are more 'other-focused' and exhibit more pro-social behaviour than those with an independent self–construal (van Baaren et al., 2004). Social dilemma researchers have suggested an independent self–construal is associated with less cooperative behaviour and a greater focus on selfish benefit an interdependent self–construal (De Cremer & van Lange, 2001; McClintock & Allison, 1989). Thus, an observer's self-construal may affect subsequent pro-social behaviours towards an interacting dyad. Therefore, in the current study I considered participant's self-construal as a moderator on participant's willingness to engage in conversation with an interacting dyad as a function of NVM.

I draw on the self-serving bias in the perception of cues to justify why one's self-construal may affect judgment accuracy regarding the relationship between the interacting dyad. Aron's paradigm of closeness (Aron & Aron, 1986) suggests that those who have a greater preference for closeness with others in general, and who emphasise the importance of interdependence, will be more likely to recognise affiliation cues of a target than those who have less of a preference for closeness, or emphasise the importance of independence (Aron, Aron, & Smollan, 1992). Hence, having an interdependent self–construal increases perceptions of affiliation with others (Galinsky, Ku, & Wang, 2005; Lakin & Chartrand,

2003). Research has also shown that information related to those we feel closest to may be prioritized in memory due to the overlapping representations of the self and the other (Aron, Aron, Tudor, & Nelson, 1991; Symons & Johnson, 1997). Based on Aron's reasoning and given that NVM is an affiliation cue (Chartrand & Bargh, 1999), it is reasonable to assume that accurate judgments are more likely to be formed if the observer recognises and uses these cues, and that those who have a greater preference for closeness are more likely to recognise NVM during third-party observations.

6.4 Study 4

This study seeks to examine whether the effects of NVM between an interacting dyad on the observer's behaviour, work through the same process as mimicry within the dyad. Specifically, I tested whether observing dyadic interactions in which the dyad either engaged in a higher amount of NVM (Romantic partners) or engaged in a lower amount of NVM (Strangers) affected willingness to engage in conversation with the interacting dyad. Willingness to engage in conversation was used as a measure of cooperation. I considered participant's feelings of closeness towards the dyad as a mediator and participant's self-construal as a moderator of this effect. I also examined whether participant's self-construal effected judgment accuracy regarding the relationship between the interacting dyad.

Considering previous research, two hypotheses are made: First, I expect willingness to engage in conversation to be higher for the increased mimicry condition (romantic partners) compared to the lower mimicry condition (strangers) (H1a). I also expect this to be mediated by feelings of closeness towards the interacting dyad (H1b). Second, I expect the relationship between NVM and willingness to engage in conversation to be moderated by participants self-construal (H2). Finally, those who report increased feelings of closeness to others in general (interdependent self–construal) are more likely to recognise nonverbal

mimicry and make more accurate judgements of relationship status than those who report lower feelings of closeness to others in general (independent self–construal) (H3).

6.5 Method

6.5.1 Participants

A power analysis based on the effect size f = .295 reported by de Klerk, Albiston, Bulgarelli, Southgate and Hamilton (2020) suggested a sampling of 94 would be adequate to achieve a 0.8 effect assuming an error rate of alpha = .05. I recruited 105 participants (44 male, 61 female) through word of mouth and advertisements on social media platforms. Participants reported a mean age of 24 years (*SD* = 3.86, Range = 19-34). All participants took part in both conditions (high mimicry vs low mimicry).

6.5.2 Materials

*Closeness***.** Closeness was measured using the single-item, pictorial Inclusion of the Other in the Self (IOS) scale (Aron et al., 1992). Participants are presented with seven pairs of circles ranging from not touching at all to almost entirely overlapping and are required to select the pair that best describes their relationship. Although brief, the IOS Scale has proven a reliable measure of the subjective closeness of relationships (Gächter, Starmer, & Tufano, 2015). This simple measure has been found to be as effective as more complex multi-item measures of closeness (e.g., Aron et al., 1992; Le, Dove, Agnew, Korn, & Mutso, 2010; Mashek, Cannaday, & Tangney, 2007; Tsapelas, Aron, & Orbuch, 2009).

Self-construal. Self-construal was measured as feelings of closeness to others in general. Previous research has supported this as an effective measure of self-construal (Aron, Aron, Tudor, & Nelson, 1991; Brewer & Gardner, 1996; Symons & Johnson, 1997). When measuring self-construal this way, the Inclusion of the Other in the Self (IOS) scale (Aron et al., 1992) is adapted to measure closeness towards others in general. Such that, participants are presented with seven pairs of circles ranging from not touching at all to almost entirely

overlapping and asked to select the pair that best describes their relationship towards others in general.

Cooperation judgement. Participants were asked how willing they would be to engage in conversation with the couple they had observed, on a scale of 1 (not willing at all) to 7 (completely willing). Willingness to engage in conversation is one of the prosocial forms of cooperation (Grindler & Bennett, 2015; Wiese, Kelley, Cranor, Dabbish, & Zimmerman, 2011), thus I used willingness to engage in conversation as a measure of cooperation.

Video stimuli. Participants were shown two 5-minute video clips of virtual interactions. Each interaction was 5 minutes long as this enough for mimicry to affect face-to-face interactions (Guéguen, 2009), and considering that social perceptions are automatic (McFadden, Berry, McHugh, & Rodgers, 2021; Rudman, Feinberg, & Fairchild, 2002; Zalesny & Ford, 1990), I anticipated a 5-minute interaction also being sufficient to show third-party effects. Each video involved a heterosexual dyad engaging in conversation over individual Microsoft Teams platforms. One dyad were romantic partners who had been together for a minimum of 6 months, and the other dyad comprised of strangers. As the interaction was carried out online, the video showed a split screen: with the individuals on either side of the screen from left to right. Participants were able to watch the recordings as if part of a virtual group meeting. Dyads discussed their most favourite and least favourite movies, what they liked about them and why. This topic was chosen as it represents a common interaction in everyday life and encouraged active communication. In all clips the full upper body of the interacting dyad were visible, and the background setting was a neutral office space. All videos were muted before being observed by participants to ensure participants' focus was directed to nonverbal behaviours only. Although participants watched 2 dyads interact (1 for each condition), 4 dyads were recorded (2 for each condition) which

were randomised when presented to participants to avoid a preference for certain dyads to bias results.

Nonverbal mimicry. The naturally occurring differences in mimicry that come from different types of relationships (i.e., romantic couples displaying more nonverbal mimicry than strangers [Ashton-James et al., 2007, Bernieri, 1998; Charney, 1966; Stel and Vonk, 2010]) were used to create two nonverbal mimicry conditions. This was done to allow interactions to be as natural as possible. To ensure that the level of mimicry differed between romantic partners and strangers, two independent raters who were unaware of the research hypothesis coded the videos prior to testing participants. A mimicry score was calculated for each condition by coding the total number of mimicked instances for both videos in that condition and using the average. The total number of mimicked instances for the romantic condition (*M = 17.50, SD = .58)* was greater than that of the strangers conditions (*M = 7.75, SD = .96).* Cohen's κ was run to determine if there was agreement between the two researchers' judgement on the amount of mimicry displayed across the videos. There was good agreement between the two raters' judgements, $\kappa = .692$, 95% CI [.25, 1.13], $p < .005$.

Accuracy. Participants were asked "do you believe the individuals in the video to be strangers or romantic partners" and given the option between Romantic partners, Strangers, or I don't know for each video. Accuracy of participant's judgement were scored between 0-2, selecting an incorrect answer or selecting "I don't know" was marked as 0, whilst each correct answer was marked as a score of 1. Thus, 2 correct answers were marked as a score of 2.

6.5.3 Procedure

The experiment took place online, via Qualtrics. Participants were told that the study was examining judgments of relationship status based on witnessed interactions. After

reading the study brief and consenting to take part, participants were asked to provide some basic demographic information (i.e., age, gender, occupation). Before either video was presented, participants were first asked to complete the IOS scale for feelings of closeness towards others in general. The experiment was then split into two rounds. Each round consisted of one video being presented, followed by a series of questions about the video. Videos showed a virtual interaction between a heterosexual couple engaging in conversation over Microsoft Teams for 5 minutes. The order of videos presented were randomised across participants.

Following each video, participants were asked to rate how willingness they would be to engage in conversation with the dyad and to provide a closeness score for their feelings of closeness towards the interacting dyad. Participants were then asked to state whether they thought the interacting dyad were strangers or romantic partners. After completing the study, participants were fully debriefed and thanked for their help.

6.6 Results

Table 6.1 shows the mean scores for closeness, cooperation, and self-construal according to mimicry condition. As can be seen, closeness and cooperation scores were highest in the high mimicry compared to the low mimicry condition. Scores for participants' self-construal were higher in the high mimicry condition compared to the low mimicry condition, however the difference was non-significant.

Table 6.1 *Means of closeness, cooperation, and self-construal scores according to mimicry condition*

Condition	Closeness score		Cooperation		Self-construal	
	M	**SD**	**M**	**SD**	**M**	**SD**
High Mimicry	3.91	1.20	4.50	1.25	4.34	1.36
Low Mimicry	2.59	1.06	2.83	1.51	4.28	1.37

6.6.1 Cooperation judgments

To test the predictions that closeness mediates the relationship between NVM and cooperation, I used the PROCESS macro (Hayes, 2017) to run a mediation analysis and tested the significance of the indirect effect using bootstrapped (n = 10,000) confidence intervals. The path (direct effect) from mimicry to willingness to engage in conversation was statistically significant (b = .71, SE = .19, p< 0.001) 95% CI [.35, 1.70]. The path (direct effect) from closeness to willingness to engage in conversation was positive and statistically significant (b = .76, SE = .07, p< 0.001) 95% CI [.62, .90]. The bootstrapped standardized indirect effect (IE = 1.049) of NVM on willingness to engage in conversation mediated by closeness was statistically significant: 95% CI [.71, 1.44].

To test the predictions that self-construal moderates the relationship between NVM and willingness to engage in conversation, I used the PROCESS macro (Hayes, 2017) to run a moderation analysis and tested the significance of the effect using bootstrapped (n = 10,000) confidence intervals. The effect of self-construal on willingness to engage in conversation was nonsignificant (b =-.34, SE = .21, p = .100) 95% CI [-.75, .07]. The interaction term of self-construal was nonsignificant (b =.20, SE = .13, p = .142) 95% CI [-

.06, .46], suggesting that the relationship between NVM and willingness to engage in conversation is not conditional on participant's self-construal.

6.6.2 Judgment accuracy of relationship status

There was a statistically significant difference in accuracy of relationship status judgment according to participant's self-construal, F (2,104) = 20.78, p <.001, η_p^2 = .294, 95%CI [.145, .413]. Participants with an accuracy score of 2 reported increased feelings of closeness to others (*M =4.74, SD = 1.18*) compared to those who had an accuracy score of 1 (*M = 4.25, SD = 1.29*) and an accuracy score of 0 (*M = 2.91, SD = 1.08*).

6.7 Discussion

Study 4 first sought to examine whether third-party observations of NVM affect judgments of cooperation towards an interacting dyad and test if the effects of these judgments are mediated by feelings of closeness. Results were consistent with our hypothesis that third-party observers would be more willing to engage in conversation with dyads when the dyad engaged in more mimicry. This is consistent with previous research showing that social judgements of trustworthiness are unconsciously influenced by third-party observations of NVM (Kavanagh et al., 2013), and demonstrates that the effects of NVM extend to an observer's judgment of cooperation towards an interacting dyad. Further, our results showed that closeness towards an interacting dyad acts as a mediator of the effects of NVM on willingness to cooperate with the interacting dyad. This demonstrates that NVM is sophisticated and can influence willingness to cooperate even when not directed towards us.

Previous research has yet to address how mimicry works to influence social judgements of cooperation from a third-party perspective. Our results provide one insight into this relationship, by showing a role of closeness. Chapter 3, 4, and 5 of the current theses

showed closeness as one of the psychological processes behind why dyadic mimicry works to increase cooperation. As such, our findings in the present study suggest that when observed from a third-party perspective, the effects of NVM may work through the same process as mimicry within the dyad. Moreover, these feelings of closeness are specific to the dyad being observed and not feelings of closeness in general. For feelings of closeness to others in general (i.e., participant's self-construal) I found no effect on willingness to cooperate, and no moderation on the effects of NVM. This is contradictory to research suggesting that an individual's self–construal is associated with less cooperative behaviour (De Cremer & van Lange, 2001; McClintock & Allison, 1989). Thus, our findings may suggest that feelings of situational closeness are more strongly related to observations of NVM, and as a result overtook the effects relating to an individual's dispositional closeness.

A final aim of the present study was to test if feelings of closeness towards others in general (self-construal) determines accuracy of judgments about the relationship status of the interacting dyads (e.g., if they were romantic partners or strangers). This was based on research which shows that individuals have a self-serving bias in the perception of cues (Wall, Taylor, & Campbell, 2016) and those who have a greater preference for closeness with others in general, will be more likely to recognise affiliation cues of a target than those who have less of a preference for closeness with others in general (Aron, Aron, & Smollan, 1992). Considering that NVM is an affiliation cue (Chartrand & Bargh, 1999), I predicted that those with increased feelings of closeness towards others in general would be more likely to make accurate judgements than those who reported lower feelings of closeness to others in general. Our findings supported this hypothesis and were consistent with previous research suggesting that self-serving differences exist in the recognition of behavioural cues (Back & Nestler, 2016; Wall, Taylor & Campbell, 2016). From this, we may assume that individuals who have a greater preference for closeness with others may be more likely to recognise social signals,

such as mimicry, and use to guide their social judgments than those who have a lower preference for closeness with others. However, from the current results it is not possible to argue that observations of NVM directly influenced accuracy and more rigorous research would be needed to examine this in greater depth before any such claim can be made.

Additionally, findings from the present study highlight how NVM shapes behaviour online. An abundance of research has examined NVM during face-to-face interactions (Chartrand & Bargh, 1999; Chartrand & Van Baaren, 2009; Genschow et al., 2018), whilst how NVM works when interactions are carried out virtually remains unclear. Our findings demonstrated that observations of increased NVM between two individuals interacting virtually influences willingness to engage in conversation with such individuals. These findings demonstrate that the positive effects of mimicry on cooperation found in study 2, and in previous research (Haidt et al., 2008; McNeill, 1995; Shaw et al., 2015) when interactions were carried out in-person, are consistent for virtual interactions.

While the study has provided the first evidence of the effects of observed NVM between a dyad on subsequent judgements of cooperation with such dyad, it is not without its limitations. One limitation refers to the fact that I examined self-reported cooperation and not measure actual cooperation behaviour. Therefore, the current findings are only able speak of a person's intention, not their actual behaviour. In the present study a behavioural measure of cooperation was not sure as it would have interfered with the experimental design. Research has demonstrated that one's intended behaviour does not always equate to actual behaviour (Chatzisarantis, Biddle, & Meek, 1997; Grimmer & Miles, 2017), thus previous research should examine the effects of third-party observations of NVM on a behavioural measure of cooperation.

A second limitation is that this study focused only on observed interactions between heterosexual pairs only and did not examine the effect of NVM on willingness to engage in

conversation of the interacting dyad were same-sex dyads. Previous research has shown that sex differences may exist in how much NVM one might engage in (Hoffman, 2008; Surakka & Hietanen, 1998). Lehane (2015) argued that females may engage in more nonverbal mimicry of their interaction partner than do men. Thus, a dyad composed of two females may have engaged in greater amounts of NVM than would a male dyad. Subsequent cooperation judgments may, therefore, may be increased in the former, and reduced in the latter. Future research should aim to examine whether third-party observations of NVM have different effects on an observer's willingness to engage in conversation with the observed dyad when the dyad is either a heterosexual or same-sex pair.

CHAPTER SEVEN: GENERAL DISCUSSION

Nonverbal mimicry plays an important role in fostering the formation and maintenance of harmonious relationships. Previous research has suggested that engaging in nonverbal mimicry during interpersonal interactions leads to prosocial consequences, such as increased cooperation (Bailenson & Yee, 2005; Haidt et al., 2008, McNeill, 1995, Shaw et al., 2015). This thesis examines whether nonverbal mimicry works to increase cooperation through the mechanism of closeness. The overall findings show that nonverbal mimicry is associated with increased cooperation in an interaction partner and that closeness mediates this relationship. This thesis also showed that third-party observations of NVM increases willingness to cooperate, and the effects of mimicry in this context may work through the same social processes as mimicry within the dyad. In this Discussion Chapter, I will first summarise the results of the four empirical studies and how these address the limitations of previous research in the field of nonverbal mimicry. I will then discuss the theoretical implications and practical implications of these findings. The Chapter will end with a discussion of the limitations of the current work and make suggestions for future research to address.

7.1 Summary of experimental chapters

Previous research into NVM argues that mimicry serves a "social glue" function because it helps create liking and facilitates harmonious interpersonal interactions (Hale & Antonia, 2016; Lakin, & Chartrand, 2003; van Baaren, Holland, Kawakami, & van Knippenberg, 2004). The ostracism and social exclusion literature provide support for this view, citing evidence that those who risk social exclusion tend to engage in increased nonverbal mimicry. Lakin et al. (2008), for example, showed that NVM was used as a tool by participants to regain their status within an ingroup after being rejected by them. Likewise,

Uldall et al. (2008) demonstrated how the need to belong triggers increased NVM of one's interaction partner. Consistent with the social glue theory, NVM has been shown to aid harmony within existing interpersonal relationships and during relationship formation by increasing cooperation (Hess, Philippot, & Blairy, 1999; Maddux et al., 2008). Indeed, the positive social consequences of NVM are well established across the literature, such as better outcomes in negotiations (Maddux et al., 2008), and increased perception that a person is understanding (Hess, Philippot, & Blairy, 1999). However, the precise mechanism through which NVM influences positive social consequences remains a matter of debate. This thesis aimed to provides robust evidence for closeness as one of the psychological mechanisms underpinning how NVM works.

Before examining whether closeness is a mediator on the effects of NVM, it was important to first demonstrate that a positive relationship between NVM and closeness exists, using robust measures. In Chapter 3, I examined how naturally occurring NVM varies across different forms of established relationships previously shown to differ significantly on measured relationship closeness scores (Gächter, Starmer, & Tufano 2015); strangers, acquaintances, and romantic partners. Consistent with my hypothesis, the experimental study (Study1) presented in this chapter found an increased sense of closeness to a partner being associated with more NVM of that partner. Additionally, Chapter 3 addressed a related limitation of the previous studies on the relationship between NVM and closeness, relating to NVM in previous work not being properly defined. Across previous research it is unclear whether there are regions of mimicry (discreet body movements) more significantly related to closeness than others. Thus, chapter 3 examined the effects of mimicry broken down by body part. Although all conditions were significant, I found a difference in strength of effect between conditions in movement of the head and torso, legs, and arms. When broken down into discreet areas the effects of closeness on mimicry were reduced in compared to when

mimicry I examined full-body mimicry (collectively considering discreet areas), particularly for the right and left arm. The behaviours that showed the highest frequency of being mimicked in chapter 3 were used to create a list of behaviours for confederates to mimic in chapter 4. The nonverbal behaviours chosen created a full body level of mimicry, involving the upper body movements, lower body movements, and posture. This behaviour list was intended to be also used in chapter 5, however due to COVIE-19 restrictions, this study was carried out virtually. Considering that the upper body (torso, head, left arm, and right arm) showed a significant effect of closeness on NVM in study 1, I was confident that adapting the behaviour list to include only upper body mimicry would be sufficient for NVM to show an effect in study 3 .

Chapters 4 (Study 2) and 5 (Study 3) built on the findings from chapter 3 by examining whether an increase in NVM leads to an increase in cooperation through closeness. To do this, the studies examined the effect of NVM on cooperation by manipulating dyadic NVM to varying degrees (hard mimicry, soft mimicry, and no mimicry) and measuring subsequent cooperation. Chapter 4 measured cooperation in two ways: as the outcome of an economic exchange game and by a willingness to disclose personal information. The findings of chapter 4 supported a positive linear relationship between NVM and closeness, an increase in NVM lead to a significant increase in closeness. However, our findings showed that there was a nonsignificant effect of NVM and closeness on cooperation during an economic exchange and information disclosure. Results also showed no mediation effect of closeness. These findings were surprising, and contradictory to the strong association between NVM and cooperation (Haidt et al., 2008; Maddux et al., 2008; McNeill, 1995), as well as between closeness and cooperation (Aron, Melinat, Aron, Vallone, & Bator, 1997; Slatcher et al., 2010) evident in previous research. However, in this chapter, measures of cooperation were binary, this meant that participants were given the option to cooperate or

not cooperate. I had chosen to measure cooperation in such a way to allow for a clear and simple interpretation of findings, before realising its limitations. However, as I progressed through data collection, I realised that although using a binary measure of cooperation has the advantage of simplifying data analysis and interpretation of findings, binary measures are less sensitive to change compared to continuous measures (Kwofie et al., 2021). As such, these findings were unable to speak to the question of how much cooperation these variables generate. Additionally, previous research that has shown a direct link between nonverbal mimicry and cooperation has used a continuous measure of the latter. For example, Maddux et al. (2008) measured cooperation as the total number of points obtained during a negotiation. Moreover, previous research demonstrating a direct link between closeness and cooperation used a continuous measure of the latter, by measuring a progressive increase in cooperation (Aron, Melinat, Aron, Vallone, & Bator, 1997). I have learned from this process and addressed this methodological limitation in chapter 5 by quantifying the measure of cooperation rather than using a dichotomous measure. In Chapter 5 cooperation was measured by the degree of participant's information provision when exposed to varying degrees of mimicry, from hard through soft to none. This Chapter also provided context to the study and focused on a mock forensic interview to see whether cooperation could be influenced in this context. Previously, the experimental task involved participants working together to solve riddles, this was adapted in chapter 5 as a pseudo-forensic context allows for more generalisation into real forensic setting. The results showed that the degree of increase in information disclosure as a result of NVM was mediated by the degree of increased closeness. Thus, our findings provide support for the "social glue" hypothesis, that mimicry may help bind people together and facilitate harmonious interpersonal interactions and show that one way in which it does this is through closeness (Hale & Antonia, 2016; Lakin, & Chartrand, 2003; van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Additionally,

considering that research has shown strong evidence that interpersonal closeness mediates the social consequences of facial mimicry (Au & Lo, 2020; Cooke et al., 2018; Peng, Zhang, & Hu, 2021), our findings suggests that both forms of mimicry (nonverbal mimicry and facial mimicry) may work through the same process.

Taken together, the findings from chapter 3, 4, and 5 are consistent with the argument that mimicry may serve as a cooperation-enhancing mechanism (Maddux, Mullen, & Galinsky, 2008). Chapter 3, 4, and 5 also addressed the psychological mechanisms through which mimicry works, providing new insight into the relationship between nonverbal mimicry and cooperation, by demonstrating the important role of closeness in a rigorous and robust way.

The final empirical study extended this finding to third party observations. Although a vast amount of research has been dedicated to dyadic mimicry (Hess, Philippot, & Blairy, 1999; Maddux et al., 2008; Swaab, Maddux, & Sinaceur, 2011; Valdesolo, Ouyang, & DeSteno, 2010), to my knowledge, no previous research has examined third-party judgements of cooperation based on observations of NVM between an interactant pair. Understanding how mimicry influences social judgements is important as judgments towards unfamiliar individuals influence attitudes and subsequent behaviours toward those individuals (Rosnay, Cooper, Tsigaras, & Murray, 2006; Skinner, Meltzoff, & Olson, 2017). The impact of observing NWM on social judgements was shown in a study by Kavanagh, Bakhtiari, Suhler, Churchland, Holland, & Winkielman, (2013), who showed that judgments of trustworthiness were unconsciously influenced by observations of NVM, such that those who engaged in NVM of an interaction partner were rated as more trustworthy than those not engaging in NVM. While this effect has been shown by other studies examining trust (Kavanagh et al., 2013) and by studies examining other social judgements, such as competence (Kavanagh, Suhler, Churchland, & Winkielman (2011) and dominance (Genschow & Alves, 2020), no

research to date has examined the effects of third-party observations of NVM on willingness to cooperate. Chapter 6 addressed this question. Using willingness to engage in conversation as a prosocial form of cooperation (Grindler & Bennett, 2015; Naughton, 2006; Wiese, Kelley, Cranor, Dabbish, & Zimmerman, 2011), Chapter 6 (study 4) examined how this willingness was impacted by observations of NVM between interacting dyads and the role of closeness as a mediator. Due to national lockdown restrictions, chapter 6 had to be carried out virtually. Carrying out chapter 6 online also allowed us to examine how observed NVM shapes behaviour online, which has not been explored in previous research. The results from this study showed that third-party observers were more willing to engage in conversation with a dyad who engaged in the most mimicry (romantic partners) compared to a dyad who engaged in less mimicry (stranger dyad). Our results showed that observing higher amount of nonverbal mimicry compared to a lower amount of nonverbal mimicry increases an observer's willingness to cooperate with the interacting dyad. It also showed that the effects of mimicry in this context may work through the same social processes as nonverbal mimicry within the dyad: felt closeness to the interaction partner. Chapter 6 considered two types of closeness: situational (feelings of closeness towards another at a particular point in time) and dispositional (feelings of closeness to others in general, also referred to as self-construal), as both have been implicated in increased cooperation behaviour (De Cremer & van Lange, 2001; McClintock & Allison, 1989). The results in Chapter 6 show that situational closeness was significantly related to observed NVM and had a mediation effect on the relationship between observations of NVM and participant's intention to cooperate with the interacting dyad. Dispositional closeness showed no significant effect on cooperation judgments and did not moderate the effects of NVM. Thus, these findings provide new insights into the relationship NVM and the two types of closeness, by demonstrating that feelings of

situational closeness are more strongly related to observations of NVM than dispositional closeness.

Taken together, chapter 6 extend the findings from the prior experimental chapters by showing that the evolved "social glue" function of mimicry extends to third-party observations of mimicry and providing new insight into the relationship between nonverbal mimicry and social judgements. This study also went one step further by highlighting the role of both types of closeness in the relationship between NVM and judgments of cooperation.

Moreover, previous research has suggested that I are more likely to recognise cues related to adaptive actions (Erdelyi, 1974; Fink & Penton-Voak, 2002). As such, it would make sense that those who intend to interact with a target would be more likely to recognise affiliation cues of a target than those who do not intend to interact with the target. Considering that NVM signals an affiliation goal (Lakin, & Chartrand, 2003), in Chapter 6 I examined whether those who have a greater preference for closeness to others in general (interdependent self-construal) are more likely to recognise NVM during third-party observations than those with lower feelings of closeness to others in general (independent self-construal). Findings showed that those with a more interdependent self-construal made more accurate judgments regarding the relationship status of both conditions compared to those with an independent self-construal. From this, it may be possible to assume that individuals with an interdependent self-construal are more likely to recognise social signals, such as mimicry, and use to guide their social judgments than those with an independent self-construal. However, I recognise that I did not examine whether participants consciously or unconsciously recognised instances of nonverbal mimicry. In light of this, future research should aim to directly examine the effects of observing NVM on accuracy judgments in a more rigorous way. One possibly way to examine this may be to determine whether regions of the brain associated with unconscious recognition of mimicry (such as the "mirror neuron

system" [Blakemore & Frith, 2005; Iacoboni & Dapretto, 2006]) are more active in those with an interdependent self-construal than those with an independent self-construal when observing instances of third-party mimicry between dyads.

7.2 Theoretical implications

Altogether, this thesis shows that closeness is one of the psychological processes behind why NVM works to increase cooperation. This thesis also extended current understanding by showing that the mediating role of closeness is consistent both within the dyad and following third-party observations of NVM. This is complementary to previous research suggesting that interpersonal closeness motivates increased prosocial behaviour (Cialdini et al., 1997; Korchmaros & Kenny, 2001). For example, Maner et al. (2002) suggested that the increasing interconnectedness of the self and one's interaction partner is the core influence of increased prosocial behaviour towards that partner. Korchmaros and Kenny (2001) also supported closeness as correlational with helping behaviour. Hence, it makes sense that increased feelings of closeness following NVM may facilitate increased prosocial behaviour in the form of cooperation.

These findings are also complementary to previous research demonstrating that when one feels close to another, they are more likely to divulge personal information (Slatcher et al., 2010; Wiese, Kelley, Cranor, Dabbish, & Zimmerman, 2011). For example, Atkinson et al. (2003) argued that during investigative interviews, increasing perceptions of closeness between the suspect and the interviewer has been shown to facilitate cooperation. Additionally, the role of closeness as a mediator on the effects of mimicry, as shown in the current thesis, has important theoretical implications as they may provide an insight as the why some additional processes have been linked to NVM. For example, research has suggested that engaging in NVM leads to an increase in empathy. Stel, van den Bos, and Bal

(2012) showed that NVM of a victim or an unrelated person's behaviour subsequently reduced victim blaming, through an increase in empathy towards the victim (Stel, van den Bos, & Bal, 2012). Although this was not measured directly in the current thesis, I speculate that the effects attributed to an increase in empathy is directly related to an increase in closeness. I draw on previous research suggesting that increased self-other overlap leads to empathy-induced helping behaviour (Cialdini et al., 1997). For example, a study by Cialdini and colleagues (1997) showed that empathetic concern for another led to willingness to help the other through the process of closeness. If self-other overlap was not increased, empathetic concern did not lead to increased willingness to help. Further, previous research examining prejudice reduction techniques have found that engaging in perspective taking can reduce stereotyping and prejudice through the inclusion of the other in the self (Galinsky and Moskowitz, 2000, Vescio et al., 2003). Likewise, empathy for another's pain has been shown to depend on shared representations of self and other (Brass, Derrfuss, Matthes-von Cramon, & von Cramon, 2003; Liepelt, von Cramon, & Brass, 2008). As closeness increases and representations of self and other become increasingly overlapping, it becomes difficult to distinguish the pain of the other from the pain of oneself. Thus, the effects of mimicry attributed to the process of increased empathy may be directly related to increased closeness in which empathy is a 'by product'. With this in mind, it is possible that other mechanisms previously related to mimicry, such as similarity (Choi, Kornfield, Takayama, & Mutlu, 2017), liking (Vonk, et al., 2008), and familiarity (Guéguen, 2007) may be by-products of increasingly overlapping representations of the self and other. However, this is of course speculation and future research should be dedicated to answering this question.

Previous research into social relationships has demonstrated that individuals who have an interdependent self-construal define themselves with reference to their social relationships and are more likely to engage in increased pro-social behaviours than those with an

independent self–construal (van Baaren et al., 2004). In contrast, those with an independent self-construal are more likely to define themselves as more separate from others and are more focused on selfish benefit (Markus & Kitayama, 2001, 2003). However, when examining the effects of self-construal on willingness to cooperate in Chapter 6, no significant direct effect was found, and self-construal did not moderate the effects of NVM. Instead, feelings of closeness towards the dyad had a significant effect on willingness to cooperate. This may suggest that feelings of situational closeness are strongly related to observations of NVM and cause the effects relating to an individual's self–construal to be reduced. This is consistent with research suggesting that the strength of one's self-construal on social interactions can fluctuate depending on the social context (what kind of interaction is taking place and who the interaction partner is) (Kagitcibasi, 1997; Uleman et al., 2000). However, further research would be required to test this explanation directly.

Finally, although this thesis focused on NVM, previous research has also shown that verbal mimicry facilitates prosocial behaviour (Duffy & Cartrand, 2015; Wang & Hamilton, 2012). For example, verbal mimicry leads to increased compliance with charitable donations (Kulesza, Dolinski, Huisman, & Majewski,2014), pro-social orientation towards the mimicker (Lakin et al., 2008), higher rates of persuasion (Tanner et al., 2008), and much like nonverbal mimicry, can facilitate negotiations (Swaab et al., 2011). Thus, the prosocial consequences of verbal mimicry appear consistent with those of nonverbal mimicry. The current thesis showed that NVM works through the process of closeness, whether verbal mimicry works through the same processes as nonverbal mimicry, would be interesting for future research to explore as it would suggest that the social glue function associated with NVM also extends to verbal mimicry.

7.3 Practical implications of findings

During investigative interviews, the ability to influence cooperation is one of the key principles underpinning the success of information gathering approaches (Brimbal et al., 2019). Currently, information gathering approaches focus on the understanding and training of verbal tactics such as open-ended questions, encouraging the suspect to tell their side of the story, and evidence disclosure (Meissner et al., 2014; Miller, Redlich, & Kelly; 2018; Oates, Prasad, & Lesser, 1997). However, cooperation can be achieved through both verbal and nonverbal communication (Boone & Buck, 2003; Valdesolo, Ouyang, & DeSteno, 2010; Stel, M., & Vonk, 2010), yet less training is dedicated to nonverbal tactics. The findings from this thesis suggest that NVM may offer another approach to information gathering. Not only do the overall findings demonstrate that NVM is positively related to cooperation, but Chapter 3 identifies specific behaviours that increase closeness (one process through which NVM has an effect on behaviour), which could be used when designing mimicry training material. Our findings in Chapter 3 showed that mimicry of these discreet areas of the body may have different effects on feelings of closeness have important implications for future research involving experimental manipulations of NVM. When mimicry across the body was examined collectively (full body), there was a more significant effect of closeness than when I examined across specific regions. Considering this, mimicking behaviours that collectively create a full body level of mimicry would be more effective in increasing closeness than just mimicking discrete behaviours such as arm movements. This is an important finding because research has shown that higher levels of cooperation lead to more prosocial outcomes compared to lower levels of cooperation (Oleszkiewicz, Granhag, & Cancino Montecinos, 2014). Moreover, given that the main objective of investigative interviewing is to gather as much information from a source as possible (Fisher, 2010), our findings suggest that training in nonverbal mimicry for investigative interviewers may be beneficial for influencing

cooperation of a source. Chapter 5 was carried out online and the effects of NVM on cooperation were still significant, suggesting that NVM could be implemented to increase cooperation during both in-person interactions and virtual interactions. What is more, Chapter 6 showed that the effects of NVM are sophisticated enough to influence willingness to cooperate even when not directed at the individual, and thus, training of NVM between interviewers may also be an effective cooperation enhancing tactic. Simply put, observing two individuals engaging in NVM was shown to increase participants willingness to cooperate with the interacting dyad. Thus, these findings suggest that the training of NVM between interviewers may also be an effective cooperation enhancing tactic. Furthermore, considering that closeness mediates the strength of NVM on cooperation, contexts designed to help facilitate closeness would be most beneficial on the degree of cooperation. For example, reciprocal self-disclosure has been shown to increase feelings of closeness (Sprecher, Treger, & Wondra, 2013), thus implementing NVM in congruence with self-disclosure and other closeness enhancing techniques may increase the likelihood and degree of cooperation. However, this was not tested directly in the current thesis, and training individuals to engage in nonverbal mimicry whilst conducting an interview may lead to an increased cognitive burden or potentially hinder emotional understanding of the interviewee by the interviewer (Muniak et al., 2021). Future research examining this directly is needed to confidently determine whether nonverbal mimicry could be integrated into the training of investigative interviewers to help increase cooperation of an interviewee.

Covid statement

The COVID-19 pandemic began midway through my second year, this caused significant complications with the intended studies in the following two years. The thesis was initially intended to consist of four in-person studies examining nonverbal mimicry during face-to-face interviews. Due to national lockdown and social distancing measures, several

studies which had been designed and approved by the university ethics committee were unable to go ahead and needed to be redesigned or removed. As such, the progressing in the final stages of my thesis were significantly interrupted, however these unfortunate circumstances have meant that the final two studies in this these examine the effects of nonverbal mimicry on cooperation in a virtual interaction, a field with limited understanding. For this reason, despite this thesis diverging from its intended path and the disruption caused by the pandemic, the quality and application of work completed is strong, highly valuable, and novel for both face-to-face and virtual environments.

7.4 Limitations and directions for future research

The findings outlined earlier in this chapter and throughout this thesis have several important implications for our understanding of mimicry and provide new insight into the relationship between nonverbal mimicry and cooperation. However, the studies presented in the current thesis are not without limitations. I have discussed the limitations of individual studies in the discussion section of the appropriate chapter, however in this section I will discuss the overall limitations of the current thesis and make recommendations for future research.

First, the studies presented throughout this thesis demonstrate that closeness is one of the psychological mechanisms through which mimicry works. While the current thesis showed the important role of closeness, it was not possible to show the relative importance of closeness when compared to other mediators. The ability to consider each of these possible mechanisms in much detail goes far beyond the scope of the present thesis, and future research is needed to examine other possible mediators. However, it was important to prioritise closeness over other mechanisms because recent research has provided strong evidence that interpersonal closeness, conceptualised as self–other overlap, mediates the

social consequences of other forms of mimicry, such as facial mimicry (Au & Lo, 2020; Cooke et al., 2018; Peng, Zhang, & Hu, 2021). When examining the NVM literature, it was evident that a similar pattern was emerging, however this emerging evidence was lacking a reliable measure of both closeness and NVM.

Second, previous research has argued that mimicry may be moderated by sex differences (Lehane et al., 2015), and the way in which men and women mimic differ according to factors such as frequency, time, and the behaviours mimicked (Buck, 1984; Hall, 1978; Hoffman, 2008; Surakka & Hietanen, 1998). Sex differences in NVM may exist due to males and females using different cognitive processing strategies when observing another individual's motor movements (Cheng et al., 2009; Yamasue et al., 2008). Chapter 3 controlled for sex differences by examining mimicry of discreet areas across an equal number of same sex and opposite sex pairs. However, in chapter 4 and 5 all participants were female. This was due to the confederates available to take part in the study all being female, thus, to keep the sex between dyads consistent, an all-female sample was required. Although research has suggested that sex differences may exist in how much NVM one might engage in, other researchers has shown that no sex differences relating to the effects of being mimicked on prosocial behaviours (e.g., Ashton-James et al., 2007; Van Baaren, et al., 2004). Therefore, I must assume that the effects of being mimicked on cooperation would not differ with male participants, relying on future research to examine this directly.

Additionally, in Chapters 4 and 5 cooperation was measured directly after the mimicry event. Likewise, in Chapter 6, participants provided ratings of willingness to cooperate directly after observing instances of NVM. Thus, it was not possible to examine whether the effects of NVM on cooperation persisted after this time frame, and whether they extended to individuals who were not present during the experimental task. Previous research has attempted to examine whether the effects of mimicry on helping behaviour persist after

the interaction has finished and extend to individuals not present during the interaction. For example, Fischer-Lokou, Martin, and Guéguen, (2011) showed that participants who had been mimicked by a confederate in a previous interaction showed increased helping behaviour to a different confederate in a following interaction. Although this demonstrates that the effects of mimicry may increase helping behaviour towards other people, the time frame used in this study was also very short. It would be interesting for future research to examine the effects of NVM on cooperation using a longitudinal study design to determine how long the positive effects of NVM are observed for.

7.5 Concluding remarks

Using motion capture technology to gain precise measurements of discreet behaviours, this thesis has shown that nonverbal mimicry is positively associated with increased cooperation, and the strength of this effect is mediated by interpersonal closeness. Further, this thesis demonstrates that observations of mimicry from a third-party perspective works through the same processes as nonverbal mimicry within the dyad and could also be used a tool to increase cooperation. Collectively, these findings shed light on the psychological mechanisms underpinning how nonverbal mimicry works and suggest that investigative interviews may benefit from the inclusion of nonverbal mimicry as a tool to increase cooperation of a source.

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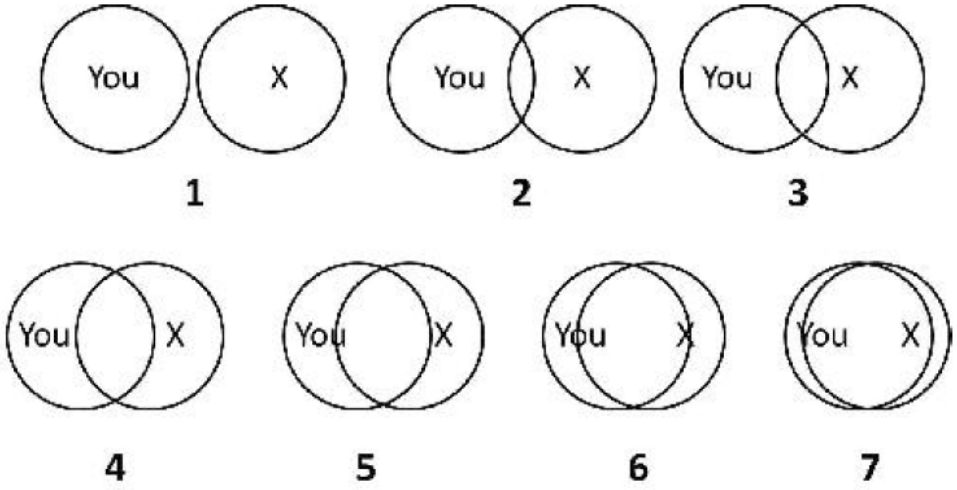
Appendix

Appendix A.1. Inclusion of the Other in the Self (IOS) scale (Chapter 4 & 5)

The "Inclusion of the Other in the Self" ('IOS' for short) scale proposed by Aron et al. 1992. (Journal of personality and social psychology, 63(4), 596).

In the following figure we ask you to consider which of these pairs of circles best describes your relationship with the person in whom the experimenter has partnered you with (referred to as {X}). By selecting the appropriate number please indicate to what extent you and {X} are connected.



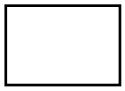
Appendix A.2. Economic Exchange (Chapter 4)

You have been given £2.50
You can either keep the £2.50 or transfer it to a partner, where it would be quadrupled to £10.
Your partner has the option to either keep the entire £10 or give half of it back (£5).

It is up to you whether you would like to keep the £2.50 or transfer it to your partner.

It is common for individuals to want to share contact details with their fellow participant in order to meet after the study. They were asked to

Please tick the box bellow if you would like the experimenter to share their contact details with your fellow participant.



Appendix A.1. Riddles (Chapter 3, 4, & 5)
These were printed on card, laminated, and stuck to the sidewall.

I have keys but no locks. I have a space but no room. You can enter, but can't go outside. What am I?

What flies when it's born, lies when it's alive, and runs when it's dead?

Every night I'm told what to do, and each morning I do what I'm told. But I still don't escape your scold.

What comes once in a minute, twice in a moment, but never in a thousand years?

I am a mother and a father but have never given birth. I'm rarely still, but I never wander. What am I?

Hurt without moving. Poison without touching. Bear the truth and the lies. Are not to be judged by our size. What are we?

I'm always there, some distance away. Somewhere between land or sea and sky I lay. You may move towards me, yet distant I stay.

Which word in the dictionary is spelled incorrectly?

What gets wet when drying?

Appendix B.1. Instructions to the Source (Chapter 5)

Background

Imagine that economic problems, not caused by yourself, made you participate in the robbery of a cash transport van in the fall of 2007. The actual robbery went fine, but three months ago, the other three involved in the act got arrested. The only one who is still free is you, but you feel that this is only a matter of time. You know where most of the stash (approximately 45 million SEK) is kept. You understand that your time is scarce, and you immediately need to get the stash and move yourself and your money out of the country.

Some time ago you got an idea of how it could all be solved, and briefly your plan is as follows: Through a close friend you have come by information that a radical political group in Sweden has future plans to perform a bomb attack in Gothenburg, around Christmas, 2011. Your plan is to reveal information about this bomb attack to the special police force (SAPO), and in favor of the information receive free conduct out of Sweden. Ten days ago you contacted the special police (anonymously of course) and carefully asked if there was any interest in talking further about this matter. SAPO said that they were very interested in talking more thoroughly with you, **and it is this call you are now about to make.**

The group that is planning this bomb attack is called MDA16, and consists of a loosely assembled network of approximately 10 members. You are a close friend to one of those members, **and you feel some sympathy for the group's opinions.**

After a lot of consideration, you have decided to reveal some pieces of information about the planned bomb attack to the police. You do understand that it is possible that the police already have some information about the planning—partly because SAPO have conducted their own investigations, and partly because you have heard, from your friend, that a few of the members in MDA16 suspects that their phones have been tapped (but this is nothing they know for certain). In brief, you don't know what the police actually know about the planned attack (or if they know anything at all).

But before the phone call, you have a very important additional dilemma to reflect upon: When speaking to the police you should **absolutely not tell them everything you know**. First of all you have, to say the least, a negative attitude toward the police. Also, if you would reveal everything you know about the planning, it could jeopardize the entire existence of MDA16, including your close friend, and might get them convicted for planning a very serious crime. If you tell too much, there is also an obvious risk that they will find out that it was you who "sold them out," which means that you will be hunted by the entire group (and you are not prepared to go that far). On the other hand, you **cannot reveal too little**, because if you do so, there is a risk that the police won't find your contribution to be significant enough to grant you free conduct out of Sweden.

You also realize that you must avoid lying to the police because if they find out that you are lying, they might come to believe that you are trying to trick them (that is, to receive free conduct out of Sweden by revealing information that will deceive the police). In order to be taken seriously, and appear trustworthy, you have to show some degree of good will and cooperation.

In sum, you need to **find a good balance—neither revealing too much or too little information**. In spite of all the effort you have put into thinking this through, you still feel very hesitant about talking to the police at all, but nonetheless you have decided to give it a try. However, you have not fully decided what specific information (and how much) you will reveal to the police. This decision is partly held open, and you will in some degree allow the development of the upcoming conversation to direct this matter.

What you know about the planning of the upcoming attack is as follows:

General

You know that the group planning the attack is called MDA16, it consists of approximately 10 members and is located in Gothenburg. You also know that the group has been around since 2002 and came to existence as a result of the EU riots in Gothenburg 2001. You know that the group, in cooperation with two Danes, had plans to execute a bomb attack during 2006 against a conference center in Malmö where a political top meeting was held at the time. But that operation was cancelled due to internal conflicts. This conflict resulted in one of the leading figures of the group, Jari Tapio, leaving MDA16.

Your Relationship to MDA16

Petter Jönsson, who is your close friend, and Jari Tapio founded MDA16. You know the names of most of the members of MDA16: Martin, Johannes, Erik, Sara, Pär, Sigge, Lisa, but have no further personal information about them. You know the background of the internal conflict that occurred in Malmö. In brief, Jari Tapio wanted to increase the effect of the attack with human casualties, something the Danes refused to go along with. Since the other members sided with the Danes, this dispute led to Jari leaving MDA16. Jari and Petter are currently bitter enemies, as it was Petter who introduced the Danes to MDA16.

Specific Details About the Upcoming Attack

You know that five persons are working more specifically with the planning of the attack. Among these five there are two Danes (a male and a female) who are both experts on explosives. You also know that these two Danish bomb experts participated in the planning of the bomb attack that would have been performed in Malmö (2006), which was cancelled.
You know that the shopping mall subjected for the planned attack is Femmanhuset in Nordstan, and you know that the attack will take place during the Christmas holiday sales, namely the 27th of December (2011).
You also know that the plan is to plant the bomb during daytime, and that the bomb will be detonated at 11PM via an advanced remote detonator.
The bomb will be placed in an old-fashioned TV, which will be brought for repairs at 5.55PM the 27/12. That is, five minutes before closing time. The store, Elektronik Experten, where the TV will be repaired is centrally located in the mall's basement.
You do not know what kind of bomb it is. You do not know where the bomb is located at the moment (or if it is manufactured yet).

Appendix B.2. Checklist for the 35 Units of Information (Chapter 5)

The group	Called MDA16
	10 members
	People from Gothenburg
	Founded in 2002
	Founded after the EU-riots 2001
Previous planning	Have planned a previous bomb attack
	Planned a bomb attack in Malmö
	The previous bomb attack was cancelled
	Was cancelled due to an internal conflict
	Some people left the group after the conflict
	Jari Tapio left the group after the conflict
Current planning	5 people are planning the current attack
	2 persons are Danish
	There are bomb experts
	The Danes are the bomb experts
Location	Centrum
	Nordstan
	Femmanhuset
Date	Around Christmas
	After Christmas
	27th of December
Where the bomb is planted	In the basement
	In a store
	In an electronics store
	The store Elektronik Experten
When the bomb is planted	During daytime
	Around closing time ▫ 5:55PM
How the bomb is planted	Placed in some kind of apparatus
	Placed in a TV
	Apparatus/TV brought for repairs
When the bomb is detonated	During the evening
	After closing time
	Around 11PM
How the bomb is detonated	Advanced remote detonator

Appendix B.3. Questions for cooperation task.
Please rate each statement on a scale of 1-7, with 1 being “completely disagree” and 7 being “Completely agree”

I would participate in a similar study task again
I enjoyed working together to form a plan
I feel close to my fellow participant
I felt that my fellow participant and I worked well as a team
I think the task would have been more difficult if working alone
I enjoyed the careful planning at each stage
I found it difficult to consider so many variables at once
I found the overall heist task exciting
I felt I was good at coming up with a clear strategy
I felt I considered and overcame potential obstacles well

Appendix C.1

The total number of mimicked instances for the strangers and romantic partners condition

	Strangers		Romantic partners	
	Video 1	**Video 2**	**Video 1**	**Video 2**
Rater 1	7	8	14	17
Rater 2	7	8	16	17

Appendix C.2. Inclusion of the Other in the Self (IOS) scale for self-construal

In the following figure we ask you to consider which of these pairs of circles best describes your relationship with others in general (referred to as {X}). By selecting the appropriate number please indicate to what extent you and {X} are connected.