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Fast track report

Electrodes as social glue: Measuring heart rate promotes giving in the trust game ☆

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ABSTRACT

While physiological measures are increasingly used to help us understand the workings of interpersonal trust (and related behaviors), we know very little about the effects of such measures on trust. We examined the effects of a classic measure, the measurement of heart rate using a standard protocol, on behavioral trust in dyads of women who did not know each other. Behavioral trust was assessed in the trust game, in which the trustor decides how much money from their subject payment to give to a trustee, while knowing that the experimenter triples that amount before giving it to the trustee, after which the trustee decides how much money to return to the trustor. As predicted, we found greater levels of behavioral trust in the trust game, as well as greater returns by the trustees (which were accounted for by trustor's giving), in the heart rate (HR) than in no heart rate (NHR) measurement condition. Parallel findings were observed for self-reported trust. Findings are discussed in terms of the idea that the elusive effects of a protocol for measuring heart rate can cause pronounced effects on subsequent social interactions via enhanced interpersonal trust.

1. Introduction

Interpersonal trust is one of the most pervasive concepts in the social and behavioral sciences. Trust serves as social glue in that it promotes attachment and healthy social development, the vitality of interpersonal relationships, and human cooperation among friends and strangers. Recently, our understanding of trust has been enhanced by empirical research that integrates social and biological approaches, using a wide array of new techniques and non-invasive procedures that help us understand the biological bases of interpersonal trust (e.g., Kang et al., in press; Kosfeld et al., 2005; Takahashi et al., 2005; Zak et al., 2007). This scientific development begs for a deceptively simple question that has hardly been addressed: Might the mere procedure of assessing *physiological variables, such as heart rate, affect trust?*

Examining this question is important for a variety of reasons. First, from a historical perspective, it is interesting to initiate research on how the mere administration of one of the most classic, non-invasive physiological measures (i.e., measuring heart rate) might influence one of the most classic psychological constructs that is essential to understanding social interaction and relationships (i.e., trust). Second, from an empirical perspective, it is important (and timely) to assess the link between measuring heart rate and trust, because the biological aspects of trust, especially as measured in the trust game, have become a very prominent and productive field of research, a case in point being the rapid development of the field of neuroeconomics, e.g., Glimcher et al., (2008). Such findings might inform us about base-rate levels of trust in contexts that include similar non-invasive measures. Third, from a practical perspective, it is interesting to explore whether social interactions, as they often occur often in scientific contexts, as well as medical contexts (e.g., interactions between doctor (or nurse) and patient), might impact one's psychological state in the patient that influences behavior within and outside of that specific context. Thus, various lines of reasoning suggest the importance of this question.

The current research examines whether assessing heart rate, according to protocol, might affect interpersonal trust. Our approach is rooted in social psychological theorizing, which suggests that even small variations in the social environment can cause pronounced effects on human behavior. While measuring heart rate is non-invasive from a medical perspective, it may be quite impactful from a psychological perspective. To place electrodes, participants minimally need to raise their shirt in the presence of an unknown experimenter who touches them extensively with both hands to clean some parts of the skin with alcohol, and to prevent the participant from moving while putting the electrodes into place. During this process, the experimenter usually talks to the participant to explain the why and what of the procedures, thereby comforting the participant (e.g., "this may feel a little cold"). Hence, the assessment of heart rate typically involves interpersonal touch, interpersonal communication, as well as intrapersonal arousal, feelings of vulnerability, and perhaps even helplessness among participants. Do such experiences affect trust?

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Although there is no direct evidence, past research provides some tentative insights. For example, friendly touch promotes trust, cooperation, and reconciliation (Dunbar, 2010; Crusco and Wetzel, 1984; Field, 2001). It may also be that trust and cooperation may be enhanced to the degree that the presence of others is more salient, in that a stronger salience of others may yield stronger feelings of social evaluation, which in turn may promote trust and cooperation (Takahaski et al., 2007). Moreover, communicative acts of comfort and care promote trust as well, especially in threatening situations (see Simpson, 2007). Although we do not know whether arousal directly promotes trust, classic studies suggest that state arousal can cause interpersonal closeness and affiliation (e.g., Schachter and Singer, 1962), which might support rather than undermine trust. And it is possible that measuring heart rate enhances self-awareness, which in turn may make people think and behave in ways they regard favorable themselves—which seems to enhance trust rather than distrust (e.g., Duval and Wicklund, 1972). Thus, interpersonal (touch and communicating care) and intrapersonal mechanisms (arousal and self-awareness) support the hypothesis that the procedures for assessing heart rate promote trust.

To test our hypothesis, we conducted a study using the trust game (Berg et al., 1995), one of the most widely used behavioral measures of trust (Neaf and Schupp, 2009; Kang et al., in press). The game is fully described to participants who participate in pairs and are randomly assigned to the role of the trustor or the trustee. The trustor then has the opportunity to send between nothing and the entire amount of his show-up money to the trustee. The experimenter triples each dollar that is sent. After the trustee receives the transfer (i.e., three times the amount sent), he may return the money back to the trustor and the game ends.

The trust game is ideal for our purposes not only because it provides a behavioral measure, but also because the findings of the trust game have been found to be "surprisingly robust" (Neaf and Schupp, 2009; p. 4) in that responses are free from tendencies toward social desirability, and do not tend to vary with variations in stake size. Typically, trustors transfer about 50–60% of their funds to trustees, and following the principle of reciprocity, 70% of trustees or more transfer money back to trustors (see Berg et al., 1995; Croson and Buchan, 1999). We assessed self-reported arousal to examine whether measuring heart rate enhances arousal, as we assumed. Also, we explored whether arousal mediates effects measuring heart rate on trust, and whether individual variation in arousal in the heart rate measurement condition predicts trust.

2. Method

2.1. Participants and design

Fifty women with an average age of nearly 21 years ($M = 20.74$; $SD = 2.14$) participated in sessions that were run in dyads of strangers. Among the 25 stranger dyads, fifteen dyads were randomly assigned to the heart rate measurement (HR) and ten to the no heart rate condition (NHR). Role in the trust game (trustor versus trustee) was varied within dyads, with random assignment (by means of a ticket draw) to each role. Thus, we examined the effects of HR versus NHR on trustors' giving and on trustees (reciprocal) giving.

2.2. Procedure

Participants were paired with a stranger whom they briefly saw before starting the experiment. Participants drew a ticket to randomly assign them to the trustor role or the trustee role. Two experimenters then accompanied each participant to a separate cubicle. All participants read and signed an informed consent form. In the cubicle, participants in the HR-condition were connected to an Ambulatory Monitoring System VUAMS46 (de Geus et al., 1995; de Geus et al., 2007; Willemsen et al., 1996). According to protocol, experimenters placed six electrodes on participants' chest to measure their heart rate and heart rate variability (see Goedhart et al., 2007, for exact locations). To place the electrodes, experimenters cleaned the skin and placed the electrodes while touching the participant with both hands. All experimenters underwent an extensive training to learn how to place the electrodes and ensure valid measurements, and were instructed to make the participants comfortable when placing electrodes.

While placing the electrodes, experimenters explained the trust game and provided participants with a written description of the trust game. The electrodes were in nearly all cases placed by women. There were four experimenters, including one male, in total. During the experiments, two experimenters were always present, to simultaneously place the electrodes. If the male experimenter had to place the electrodes (which, as mentioned, happened for 5 participants or less), we asked participants whether they preferred to wait for a female experimenter. None of the women indicated that they preferred to wait.

Participants were informed that there was no deception in the experiment. For participants in the NHR condition, experimenters merely explained the trust game and provided the written description. Subsequently participants completed a questionnaire on the computer, including the Positive Affect Negative Affect Scale (PANAS, Watson et al., 1988) to assess arousal and other emotions. Specifically, participants rated the degree to which they were excited (in Dutch: "opgewonden") and nervous (both items; 1 = *not at all*; 5 = *very much*), as a positive and negative indicators of arousal.

Participants then played the trust game for which each participant received six Euros to invest. First, the trustor transferred as much money of this amount to the trustee as she wished. To do so, we adapted the decision making form developed by Sutter and Kocher (2004). The upper part allowed the trustor to indicate the amount of money she wanted to transfer to the trustee (0 to 6 Euros). After having put the form in an envelope, which they signed on the back, trustors opened the door of the cubicle. An experimenter took the envelope to hand it to the trustee in the neighboring cubicle. On the form, trustees saw that the amount transferred is tripled by the experimenter. Trustees then transferred as much money back to the trustor as they wished, ranging from 0 Euros (minimum) to a maximum of 24 Euros (6 Euros own money plus 18 Euros received from trustor), by completing the remainder of the form. They then put the form in an envelope, signed the back of the envelope, and opened the door of the cubicle. The experimenter took the envelope back to the trustor in the neighboring cubicle.

Following the trust game, participants continued filling in questionnaires, including a questionnaire assessing self-reported trust toward the partner in the trust game (e.g., "My partner behaves in a very consistent manner;" $\alpha = 0.90$; Rempel et al., 1985). After the experimental session, experimenters entered the cubicles and took off the electrodes for the participants in the HR condition. Participants were carefully and individually debriefed and experimenters answered all remaining questions. Finally, participants were thanked and paid.

3. Results

3.1. Behavioral trust

A one-way analysis of variance revealed that trustors in the HR-condition transferred significantly more money to trustees ($M = 5.27$, $SD = 1.28$) than did trustors in NHR condition ($M = 3.50$, $SD = 1.58$), $F(1, 23) = 9.48$, $p = 0.005$; $\eta^2 = 0.292$. On a percentage basis, trustors in the HR condition transferred 88% of their money to trustees, while trustors in the NHR condition transferred 58% of their money.

Next, we examined trustees' returns. Trustees in the HR condition returned significantly more money to trustors ($M = 9.47$, $SD = 4.26$) than

trustees in the NHR condition ($M = 5.00$, $SD = 4.95$), $F(1, 23) = 6.20$, $p = 0.020$; $\eta^2 = 0.212$. When controlling for trustors' transfer, this main effect dropped to nonsignificance, $F(1, 22) = 0.538$, $p = 0.471$; $\eta^2 = 0.024$, indicating that trustees' behavior is strongly determined by reciprocity. Indeed, the within-dyad correlation of giving was quite strong ($r(25) = 0.68$, $p < 0.05$). Thus, the effect of heart rate measurement on trustor's behavior can be parsimoniously accounted for by tendencies toward reciprocity, which are known to be strong in the trust game (as well as in several other economic games, see Van Lange, 1999). Table 1 provides a summary of the means for behavioral trust for trustors and trustees, as well as their ratings of self-reported trust, excitement, and nervousness in the HR and NHR condition.

3.2. Self-reported trust

To test our hypothesis, and to explore potential differences between trustors and trustees, we conducted a 2 (HR versus NHR) by 2 (trustor versus trustee) analysis of variance on self-reported trust. As predicted, this analysis revealed a main effect for HR versus NHR, $F(1, 23) = 5.18$, $p = 0.032$; $\eta^2 = 0.184$, indicating that participants in the HR condition trusted their partner more ($M = 3.01$, $SD = 0.43$) than participants in the NHR condition ($M = 2.74$, $SD = 0.55$). There was no main effect or interaction effect involving the trustor versus trustee variable, $F(1, 23) = 2.72$, $p = 0.112$; $\eta^2 = 0.106$, and ($1, 23) = 1.39$, $p = 0.250$; $\eta^2 = 0.057$, respectively. Thus, these findings support the hypothesis that the measurement of heart rate promotes self-reported trust.

3.3. Excitement and nervousness

In an exploratory vein, we examined the effects of heart rate measurement on excitement and nervousness, as indicators of self-reported arousal. A 2 (HR versus NHR) by 2 (trustor versus trustee) analysis of variance on self-reported excitement revealed a main effect for HR versus NHR, $F(1, 23) = 7.46$, $p = 0.012$; $\eta^2 = 0.245$, indicating that both trustors ($M = 4.67$, $SD = 1.11$) and trustees ($M = 4.67$, $SD = 1.45$) in the HR condition reported greater excitement than did trustors ($M = 3.80$, $SD = 1.81$) and trustees ($M = 3.30$, $SD = 1.25$) in the NHR condition. The same analysis for nervousness revealed a main effect for HR versus NHR, $F(1, 23) = 7.68$, $p = 0.011$; $\eta^2 = 0.250$, indicating that both trustors ($M = 3.53$, $SD = 1.64$) and trustees ($M = 3.60$, $SD = 1.50$) in the HR condition reported more nervousness than did trustors ($M = 3.20$, $SD = 1.13$) and trustees ($M = 1.80$, $SD = 1.32$) in the NHR condition. Neither of the analyses revealed a significant main effect of trustor versus trustee, or an interaction of HR versus NHR and trustor versus trustee.

In subsequent analyses, we did not find evidence for mediation of the HR versus NHR effect by excitement or nervousness. We should note, however, that the correlation of trustor's trust and excitement, $r(15) = 0.57$, $p < 0.05$, was quite substantial (and between trustor's trust and nervousness, $r(15) = 0.23$, ns). In contrast, these correlations tended to be smaller and negative in the NHR condition, for excitement, $r(10) = -0.16$, ns, and for nervousness, $r(10) = -0.31$, ns, respectively. The absence of significant mediation is understandable not only because of the small sample size, but also because most people in the HR exchanged the largest (or largest possible) amount of money, hence reducing the variance within the HR condition. We conclude that these findings support the idea that the measurement of HR cause effects within individuals (i.e., enhanced excitement and nervousness), but more importantly, between individuals as well (i.e., enhanced behaviorial trust and self-reported trust). We regard the link between the two variables an issue for future research.

Table 1
Means (and standard deviations) for behavioral trust, self-reported trust, excitement, and nervousness for trustor and trustee in the heart rate measurement condition (HR) and the no heart rate measurement condition (NHR).

	Trustor		Trustee	
	HR	NHR	HR	NHR
Behavioral trust	5.27	3.50	9.47	5.00
	(1.58)	(1.28)	(4.95)	(4.26)
Self-reported trust	3.10	2.94	3.03	2.54
	(0.43)	(0.43)	(0.47)	(0.67)
Excitement	4.67	3.80	4.67	3.30
	(1.11)	(1.81)	(1.45)	(1.25)
Nervousness	3.53	3.20	3.60	1.80
	(1.64)	(1.13)	(1.50)	(1.32)

Note: Standard deviations are in parentheses.

4. Discussion

This research reveals that a standard protocol for measuring heart rate promotes behavioral trust in the trust game, and reciprocal giving in the trustee. These novel findings are consistent with our hypothesis, which was based on the idea that trust is promoted through interpersonal mechanisms such as touch and communication signaling support and care, as well as intrapersonal mechanisms, such as arousal and self-awareness. Although measuring heart rate did enhance self-reported excitement and nervousness, such differences do not account for the differences in trust in the two conditions. As such, the findings provide initial evidence that measuring heart rate seems to promote trust, behavioral trust and self-reported trust, the mechanisms accounting for this novel effect await future research.

The present findings have important implications for theory and future research. First, they contribute to the literature by demonstrating a direct link between a specific, we believe trust-promoting, interaction with one person (here, experimenter measuring heart rate) and trusting behavior toward another person, a stranger. Thus, the social effects of measuring heart rate may extend to another participant in a laboratory setting, a phenomenon that can be understood in terms of generalized reciprocity or indirect forms of reciprocity (e.g., Nowak and Sigmund, 2005).

Second, past theorizing has emphasized the stability of trust, considering trust as a disposition, or as a stable factor in a relationship. The present findings suggest that trust may also be quite malleable. Indeed, the effects of measuring heart rate were quite pronounced: 73% of the trustors in the HR condition transferred *all* their money to trustees compared to 20% in the NHR condition. Akin to the sociometer theory of self-esteem (Leary, 2007), interpersonal trust may work like a thermometer whereby recent social interactions (or reminders thereof) determine the fluctuations in trusting mindsets with which we approach other people.

We are not claiming that heart rate measurements always have such impressive effects. Our goal here was to demonstrate, to our knowledge for the first time, that they *can*. Apart from underlying mechanisms, several intriguing issues remain to be addressed. Is the effect only observable in women? Is it dependent on individual differences? How long-lasting are these effects? And do protocols for measuring other physiological or neurological processes (e.g., measuring blood pressure, EEG, and fMRI) also promote trust? Needless to say, a greater insight into these questions should be helpful for understanding trust and cooperation in studies that use physiological measurements.

We wish to acknowledge some specific mechanisms that might illuminate the findings. As alluded to earlier, we do not know the independent (or combined) impact of physical contact, supportive communication (and evaluation), the monitoring of own heart rate, and feelings of vulnerability (and arousal) that are likely to be activated when an experimenter places electrodes. One might suggest that the feeling of vulnerability followed by receiving support and care, is an important situation in which trust can be developed and enhanced. This line of reasoning corresponds with the finding that measuring heart rate enhances nervousness, suggesting that care and

support do not entirely eliminate nervousness. Also, this account is in line with definitions of trust, which emphasize "a psychological state comprising the intention to accept vulnerability based upon the positive expectations of the intentions or behavior of the other" (Rousseau et al., 1998, p. 395). Indeed, we regard it plausible that vulnerability in combination with subsequent interpersonal support and care are important building blocks for trust.

As noted earlier, the trust game is often used to examine behavioral trust. However, this is not to imply that the measurement of behavioral trust in the trust game can only be motivated by trust. Indeed, it is possible that people gave more money to the other (a) because they were willing to take greater risk (i.e., risk), (b) because they were inspired by increasing the amount of money they could earn during this experiment (i.e., material self-interest), or (c) because they were motivated to give more money away to another person (i.e., altruistic motivation). Each of these mechanisms could help to account for the present findings, especially the explanation emphasizing altruistic motivation. In support of this mechanism, research suggests that trust and prosocial motivation are strongly interrelated (e.g., Van Lange, 1999), and that touch alone can increase prosocial behavior. For example, waiters who touch diners receive greater tips than those who do not (e.g., Crusco and Wetzel, 1984). The account in terms of risk is also possible, in that measuring heart rate may also increase the acceptance of greater risks, including risks that are nonsocial in nature (however, trust and risk are not always affected in the same way; see Kosfeld et al., 2005). Finally, the idea that material self-interest, or seeking to attain to highest possible outcome for self, also may hold some truth. At the same time, this motive often requires some level of trust, in that the highest possible outcomes can only be become a reality through a benevolent return by the other person.

We also wish to draw attention to the fact that participants in the HR condition knew that the other participant also was subject to the HR measurement procedures. This form of "common fate" (e.g., shared experiences of uncertain outcomes) may increase trust in the trustee, in that trustors may anticipate greater returns from others who were subject to the same procedure. Moreover, it is possible that common fate exerted a more direct effect (above and beyond expectations of return) on giving money to the other, because common fate may enhance feelings of connectedness ("bonding") and liking, as classic research has shown (cf. Schachter and Singer, 1962) Indeed, there is evidence that common fate can be important trigger of bonding and attraction, as well as cooperation (e.g., Brewer, 2010; for illustrations, see Van Lange and Joireman, 2008). However, the latter account is not supported by a pronounced tendency for trustees in the HR condition to return much more money than trustees in the NHR condition. Thus, we acknowledge that several processes that are rooted in common fate might account for the present findings, and that the present research does not allow us to disentangle the mechanisms rooted in common fate from those merely rooted in the measurement of heart rate.

Based on our findings, we suggest that the "base-rate" for trusting and cooperative mindsets may be higher under "vulnerable" circumstances that are psychologically meaningful (e.g., arousal and self-awareness) but at the same time involve physical closeness to (e.g., touch) and communicative acts of care by an experimenter. Such enhancement in base-rate trust is important because trust is assumed to be central to understanding social interactions, to how people approach and judge others, and to how they might interpret the actions of others. For example, it is possible that an increase in trust (through placing electrodes) may lead to a systematic overestimation of prosocial behavior, in that people may overestimate others' tendency to give others the benefit of the doubt, and perhaps underestimate other people's tendencies toward self-interest.

Clearly, in light of the various alternative interpretations, our primary explanation of the present findings should be considered as somewhat speculative. But if future research supports its validity and generalizability across various social settings, then the present findings may have interesting implications. One intriguing possibility is that they add to explaining the so-called white-coat effect—that the measurement of blood pressure by a doctor in a medical setting, compared to self-assessment at home, tends to elevate blood pressure (e.g., Verberk et al., 2005). The considerable individual variation in the white-coat effect seems conceptually similar to the individual variation we observed for self-reported arousal-variation which appeared to be predictive of trust.

Taken together, our findings suggest that the implications of the measurement of heart rate may be even broader, affecting not only biological processes, but also psychological states and behavior—interpersonal trust—that are essential to human cooperation. We already knew that electrodes may affect people, but we know now that they might trigger processes that serve as a social glue by promoting trust and trustworthiness between strangers.

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