MASTER

Self-Other Bias in Deriving Intimate Information from Shared Biosignals

Aerts, S.M.

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Self-Other Bias in Deriving Intimate Information

from Shared Biosignals

by Suze Aerts

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Supervisors:

Prof. Dr. Wijnand A. IJsselsteijn
Milou A. Feijt, MSc.

Abstract

As intimate technologies such as biosignal-mediated communication systems are entering our daily lives, it becomes urgent to address unanswered questions concerning the intimate information we tend to read into our own and others' shared biosignals (i.e., the perceived diagnosticity). Specifically, we tested the hypothesis that a so-called self-other bias occurs in the assessment of the shared heart rate signals, just like it seems to occur for word-fragment completions (Pronin et al., 2001). This bias refers to people's tendency to rate their own responses as less diagnostic than those of another person. We measured participants' perceived diagnosticity of the signals ($N = 97$), and compared self vs. other conditions using paired-samples t-test and subsequent linear mixed model analysis. First and foremost, we did not find a self-other bias occurring in the assessments of shared heart rate signals, but we did replicate the self-other bias for the word completions. In fact, our study suggests that people's perceptions and interpretations of heart rate signals may focus more on a person's psychological state than on their stable dispositional traits. Furthermore, perceived valence of the stimulus had a positive effect on the mean perceived diagnosticity score of the own response only ($\beta = .59$, $t(95) = 3.42$, $p = .001$), whereas perceived similarity and information processing style had no influence. Several potential follow-up studies are suggested to obtain a better understanding of the determinants of people's inferences about themselves and others based on shared biosignals. Ultimately, we hope that the current research will serve as a stepping stone to establish for which purposes and under which conditions biosignal sharing truly facilitates biosignal-mediated social interactions.

Keywords: biosignals, self-other bias, word-fragment completions, dispositional inferences, social interactions

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Introduction

During the past decades, online communication increasingly forms the basis for all interpersonal communication, which essentially means an exchange of information between two or more people. While digital forms of communication free us of the requirement to be physically collocated, at the same time it comes at the cost of limiting what cues are available to convey a message. Around the same time, biosensing technologies have advanced to a level where measurements of our physiology have become easily accessible to a wide audience (e.g., wearables). Perhaps the most widespread use of biosensing technology is known as biofeedback, which generally refers to providing a person with real-time information about his or her physiological activity for individual monitoring, tracking, and ultimately, control. However, given that our physiology is tightly linked to our mental states (Cacioppo et al., 2007), our biosignals - i.e., physiological measures such as heart rate, skin conductance, and respiration - might not only be relevant to ourselves, but could also provide valuable information in communication when they are shared with others (Feijt et al., 2021).

Our communication is highly influenced by the availability of social cues, the verbal or non-verbal signals that guide social interactions by helping you to “read” other people and react to them appropriately. Importantly, people often rely on these cues to facilitate social processes like empathic attunement (Feijt et al., 2018; Glueck, 2013). Additionally, researchers have noted that, when cues are absent in technology-mediated interaction, people tend to fill in the gaps in ways that are not yet understood very well (Boehner et al., 2007; Donath, 2007). It therefore comes as no surprise that shared biosignals were recently introduced as a novel physio-social cue creating various new application opportunities in our b-day interactions and interpersonal communication. However, in order to deploy shared biosignals as a useful source of social information, we first need to better understand the ways in which people interpret and react to them, how to display them in a socially meaningful way, and what issues might emerge when considering their use in online interpersonal communication (Liu et al., 2017b).

One of the existing questions, which is addressed in the current study, is what we read into our own and others’ biosignals regarding the degree of perceived diagnosticity about our own and others' internal traits or psychological states. In social situations individuals frequently form impressions about another person’s personality and aptitudes by observing their behavior. The extent to which a certain information source allows one to form such impressions is referred to as the diagnosticity of the source. The diagnosticity of various information sources will vary considerably – for example, facial expressions are deemed highly diagnostic of one’s inner emotional state, whereas pupil dilation may be less diagnostic. Perceived diagnosticity refers the extent to which humans experience a certain information source as being diagnostic. In other words, there is a difference between the *diagnosticity* of information, which is the objectively determinable amount of differentiating details, and the *perceived diagnosticity* of information, which refers to the subjective experience or estimation of the diagnosticity of these details.

Investigating how, what, and why social meaning (i.e., inferences about intimate information) is constructed from shared biosignals will contribute to our understanding of how we can facilitate self-expression and positive social interactions in biosignal-mediated communication systems. When properly deployed, shared biosignals might facilitate social connection, through clarifying and conveying our internal experiences (Liu, 2019). Especially in contexts in which feeling empathy or closeness with others is challenging (e.g., with members of socially distant groups, or physically remote others), shared biosignals might offer the opportunity to support interventions for bridging understanding with others (Liu et al., 2019). Social connection is critical to both our individual well-being and health (Cohen, 2004). For example, the feeling of being intimately connected can potentially reduce the epidemic levels of loneliness, which are very high despite the availability of a variety of new communication technologies (Janssen et al., 2010).

Prior research on biosignal sharing

Prior research in the biosignal sharing domain has mainly focused on how shared biosignals affect social interactions, although it should be noted that the amount of systematic research is relatively small, and for the most part exploratory as well as design-oriented (Feijt et al., 2021). These studies mainly point at several potential benefits of incorporating shared biosignals in social interactions as well as some issues that might emerge as a result thereof.

To begin with, because of the personal and private nature of our physiological information, exchanging these intimate signals could for instance help to establish rapport between interacting parties. Although the studies and applied methods in this field differ greatly from each other, overall these studies found that biosignal sharing offers the opportunity to influence the arising of several kinds of affiliative feelings. Based on the review paper by Feijt et al. (2021), biosignal sharing can increase feelings of connectedness, empathy, intimacy, affective interdependency, and sharing of an experience. For example, according to Liu et al. (2019), shared biosignals could promote empathy in communication by providing a means for people to understand each other's subjective experiences; their study shows that biosignals could vividly illustrate personal stories by expressing how a narrator felt at different moments.

At the same time, some concerns regarding the seamless integration of shared biosignals into interpersonal communication emerge from previous research as well. Several works have revealed potential issues of privacy surrounding the automatic sharing of data. For instance, people may have concerns about the personal sensitivity of this intimate data (Liu et al., 2017a, 2017b). Another challenge concerns the way in which the shared biosignals are perceived and interpreted; many questions still exist regarding the use of biosignals for human interpretation. According to Leahu and Sengers (2014), one needs to understand and consider the potential subjectivity of those interpretations in order to fully understand how biosignal sharing affects our social interactions. Though a handful of researchers have begun incorporating physiological data in social settings, few have addressed the perception of biosignals as useful cues for inferring your own and others' personal characteristics, i.e., its perceived diagnosticity.

In short, previously conducted research has mostly focused on potential benefits of biosignal sharing, but also pointed to complexities regarding potential feelings of discomfort with sharing, and ambiguities in how social meaning is constructed from the transmitted physiological information. Although the existing work identifies potential benefits and costs in terms of affective outcomes of biosignal communication, it does not investigate exactly how people perceive the diagnosticity of their own and others' biosignals in interpersonal interactions, neither does it provide an understanding of why observed effects take place.

The inherent properties of biosignals

The existing questions regarding the way in which biosignals are perceived and interpreted are especially relevant due to several unique characteristics of biosignals. As human beings, we continuously experience that our physiology is tightly linked to our mental states (Cacioppo et al., 2007); we tend to feel our cheeks turning reddish when feeling stressed or embarrassed, just like we sense our heat rate rising when we are aroused. Biosignals are autonomously generated, in the sense that they are generated without conscious effort, and hence can be considered unintentional cues (Goffman, 1959).

As such, our physiology is generally experienced as a form of emotional self-disclosure that is beyond our volitional control (Slovák et al., 2012), similar to other non-verbal signals such as blushing. Adding to that, our physiology is, in origin, mostly covert, private, and intimate; you have to be physically close to one another to hear their heart beat. This is a type of situation which typically only occurs within intimate relationships, such as the one between sexual partners, close friends, or parents and their children. Once we start sharing these intimate biosignals, the information that they carry all of a sudden becomes public (Feijt et al., 2021). Uncovering these biosignals that are naturally obscured can have both positive and negative effects on the communication experience and interpersonal relationships, as described earlier.

A characteristic of biosignals that complicates biosignal interpretations even further, is that biosignals are inherently ambiguous (e.g., Liu et al., 2017a); there are no one-to-one mappings of physiological signals to physical activities, experiences, or emotions, which leaves biosignal data open to multiple interpretations (Fairclough, 2009). An extensive literature review (Feijt et al., 2021) indeed suggest that people often do not know what biosignals actually mean. The researchers suggest that an important source of our difficulties with interpreting biosignals lies in our inexperience in making sense of physiological information.

Social Meaning of shared biosignals

Traditionally, our communication relies on various verbal and non-verbal communication cues. We tend to form impressions of other people based on the visible behavioral cues that they give off, such as body language, facial expressions, and voice tone and pitch (Ambady & Rosenthal, 1992; Goffman, 1959; Riggio & Friedman, 1986). However, the recent advances in biosensing technologies offer the possibility to reveal previously invisible (social) information about others, which could also affect our impressions of them. In fact, shared biosignals may have expressive capabilities similar to visible behavioral cues by conveying information about a person's mental state during subjective experiences (Janssen et al., 2010). For instance, heart rate and skin conductance are known to be associated with changes in emotion (Kreibig, 2010). In other words, because biosignals naturally change with fluctuations in cognitive and emotional states as a result of activity within the autonomic nervous system, they have the potential to serve as powerful social cues to others' hearts and minds (Liu et al., 2019). However, biosignal sharing presents this information in a way that we are still unfamiliar with, so we still need to learn the necessary skills to understand and use it (Feijt et al., 2021).

Despite the inexperience in interpreting biosignals, people do seem to have (unconscious) assumptions about what physiological signals would mean and thus possibly also say about someone's internal traits or psychological states. Indeed, research indicates that people believe that biosensors can reveal their true thoughts and feelings (Merrill et al., 2019). However, these beliefs do not always match empirical reality. When people lack knowledge about specific new technologies and their capabilities, they rely on existing beliefs about the body to explain what these technologies might be able to reveal (Merrill et al., 2019).

For instance, the biosignal heart rate has deep-rooted cultural significance in many societies, and near-universal familiarity as a feature of our lived experiences. Building on associations with intimacy and love, many heartrate sharing applications have aimed to "enhance" social connectedness by fostering feelings of intimacy (Janssen et al., 2010; Min & Nam, 2014) between people. Multiple studies have paid attention to individuals' beliefs about the meaning of their own heartrate (Parkinson, 1985; Valins, 1966). In general, these studies have revealed that elevated heartrates can yield negative interpretations about one's own mood and emotions (Young et al., 1982), such as being upset or anxious (Merrill & Cheshire, 2016). While we know that people make such appraisals based on their own biosignals, it is less clear from an empirical point of view how individuals interpret the biosignal information, such as heart rate, of another person in different contexts of social interaction. Past studies on heartrate sharing do in fact indicate that people attribute socio-emotional meaning to the heartrates of other people (Slovák et al., 2012). However, the meaning of heartrate as a computer-mediated cue is ambiguous, and its potential interpretations vary widely in different contexts (Merrill & Cheshire, 2016; Slovák et al., 2012). Consequently, it is not certain that the social consequences of transmitting physiological data will always be positive (e.g., increased intimacy).

Summarizing, the meaning of a heartrate in any given context is at once socially informative (Slovák et al., 2012) and highly ambiguous (Merrill & Cheshire, 2016). Altogether, these works suggest that the relationship between the individual (e.g., beliefs about the body and perceived capacities of particular sensors) and the context in which biosignal information is shared plays a key role in determining how the information is interpreted and understood by others with whom it is shared (Liu et al., 2017a), but also that a lot is unknown about how these factors exactly play out.

Self-other biases and their origins

Our perception of ourselves and other people, as well as the attributions we tend to make, has been extensively studied in previous research. Interestingly, these studies suggests that peoples' perceptions and beliefs are susceptible to various systematic sources of inaccuracy and perceptual, cognitive or motivational bias, which causes a general tendency to make overly charitable self-assessments (Greenwald, 1980; Pronin et al., 2012; Taylor & Brown, 1988). These positive beliefs about the self can ultimately lead to discrepancies in their own self-perception versus the perceptions of their peers (Nisbett et al., 1973; Pronin et al., 2002). The specific bias whose existence is explored in this research is the self-other bias, which was first proposed by Brown (1986). This bias refers to the general tendency for people to rate themselves as better than “typical others”. In that sense, the self-other is similar to the false uniqueness effect (McFarland & Miller, 1990), which is a systematic underestimation of similarities between the self and others. Brown (1986) asked people to rate a series of valanced trait adjectives according to how well the traits described the self and others. The results indicated that only positive attributes were rated as more descriptive of self than of others, whereas negative attributes tend to be rated as less descriptive of self than of others.

Self-other biases have been demonstrated to occur across various other research areas as well. For instance, people consistently believe that they are happier, more intelligent, and less prejudiced than others (McFarland & Miller, 1990). These findings also suggest that false uniqueness occurs for positive traits or characteristics only, because they are advantageous or socially desirable. Several types of self-other biases exist, all of which take a slightly different approach to the concept. The present study builds upon the findings of one of the studies conducted by Pronin et al. (2001), suggesting that people show a self-other bias when explaining observable responses to a set of ambiguous stimuli (e.g., “P _ _ N” or “_ AIL”); participants thought that peers' overt word-fragment completions were more diagnostic of private and unobservable personal qualities than their own word-fragment completions were. Interestingly, their results indicated the relevant asymmetry being present in the self versus other ratings when rating rated the other person's completions before providing and rating their own, while no asymmetry was shown when they rated their own completions first. Pronin et al. (2001) argue that these findings may in part reflect convictions about our "knowability". Most people feel as if their true nature is less “visible” and lies more "beneath the surface" or "backstage" (Goffman, 1959) than that of another person. They also tend to feel that public and private manifestations of the self are less incongruent for others than for ourselves (e.g., Miller & McFarland, 1987; Miller & Prentice, 1994). Lastly, people are inclined to believe that others' internal selves are more likely than our own to "leak" out regardless of situational constraints. That is, participants tend to believe that the opinion expressed in the essay corresponds with the writer's true attitude more than their own, despite the writer being situationally constrained to express a particular opinion (Lord et al., 1997).

In subsequent work, Pronin and colleagues have refined the explanation from knowability by relating it to another well-documented illusion known as the "introspection illusion". This illusion is of particular interest for this study, as it refers to the tendency to think that observable behavior is more revealing of others than of oneself, and that access to private thoughts and feelings is more critical when it is oneself, rather than someone else, who is being interpreted (Pronin, 2009; Pronin et al., 2004, 2008; Pronin & Kugler, 2007). In other words, people tend to believe that although their essential qualities can only be discerned from knowledge of private thoughts and feelings, the essential qualities of their peers are discernible from words and deeds that occur in interpersonal contexts (Andersen, 1984; Andersen & Ross, 1984). In this sense, people are essentially asserting that they are less knowable or "harder to access" than others. A plausible explanation is that people deem themselves to be more successful at gaining insight into others than vice versa (Steglich-Petersen & Skipper, 2019). Thus, the interpretation of the self-other bias concept adopted by Pronin et al. (2001) is that participants, armed with knowledge about their own private thoughts, feelings, motives, and associations, tend to see their own responses as less revealing or "diagnostic" than those of another person. The same exact approach to the concept of self-other bias is adopted in the current research.

In essence, the present study builds on a fundamental line of research in social psychology focussing on the attributions people make to explain behaviour. Jones & Nisbett (1971) famously hypothesized that "actors tend to attribute the causes of their behavior to stimuli inherent in the situation, while observers tend to attribute behavior to stable dispositions of the actor" (p. 93). This phenomenon is known as the actor-observer bias (Nisbett et al., 1973). They propose that people tend to make more personality-based attributions for the behaviour of others than they do for themselves, and more situational attributions for their own behaviour than for the behaviour of others. Thus, we are inclined to feel that our peers' actions largely reveal their personality or character, while we see our own actions as situationally determined. The actor-observer bias is essentially the same as the self-other bias, but while actor-observer bias aims at attributing behavioral outcomes, self-other bias focuses on attributing valanced trait adjectives.

The two tendencies described above roughly correspond to two other biases, which have received considerable attention in the social psychology literature. First of all, this behavior is consistent with the fundamental attribution error, a term often used interchangeably with correspondence bias (Gilbert & Malone, 1995). This bias indicates the tendency for people to under-emphasize situational explanations for another individual's observed behavior while over-emphasizing dispositional and personality-based explanations for their behavior. For example, when someone cuts you off on the way home from work, one quickly concludes that he's obviously a bad person. The other tendency to attribute positive events to their own character but attribute negative events to situational factors, is also known as the self-serving bias (Miller & Ross, 1975): when you yourself cut someone off, you will be inclined to explain this in a self-enhancing way, for instance by saying that you're just in a hurry to pick up your daughter.

The fundamental attribution error and self-serving bias each focus on a different side of the same coin; the fundamental attribution error only refers to other people's behavior, while the self-serving bias only refers to our own behavior. The actor-observer bias focuses on both. Previous research already suggested that the tendency to make external attributions about our own behavior and internal attributions about the conduct of others is particularly strong in situations where the behavior involves undesirable outcomes (e.g., Baumeister et al., 1990). However, the findings of a meta-analysis on 173 published studies involving actor-observer asymmetries in attribution by Malle (2006) suggested that the actor-observer bias, which used to play a central role in social psychology for a reasonable period of time, should be further refined and partially revised. The results showed that the classical actor-observer bias typically only appears when actors are explaining morally bad actions. When explaining morally good actions, the asymmetry should in fact reverse direction. These findings thus suggest that the perception of an action's valence, referring to its intrinsic attractiveness (i.e., positive valence) or aversiveness (i.e., negative valence), might also affect the degree of perceived diagnosticity. This theoretical valence effect indicates that we are, relative to base rates, more likely to provide situational attributions for our own actions when they seem blameworthy and dispositional attributions when they seem praiseworthy. The pattern actually reverses when we judge the actions of other people. In this case, we are more likely, relative to base rates, to provide dispositional attributions for other people's actions when they seem blameworthy and situational attributions when they seem praiseworthy. In other words, people feel that positive behaviors say something about who they are, while negative behaviors do not, but this difference works the opposite way when evaluating others' behavior.

Self-other bias in assessing shared biosignals

To date, the existing research on self-other bias has mainly focused on asymmetrical external or dispositional attributions of behavioral outcomes, in terms of successes or failures (Malle, 2006). When making such attributions of behavior, the self-other bias is often referred to as the actor–observer asymmetry. Until now, however, little attention has been paid to how social perceptions of naturally covert stimuli such as biosignals arise, by which we mean how biosignals are interpreted in interpersonal interactions. Consequently, it is not yet well understood what biosignals actually signal to another person during social interactions.

Based on the findings by Pronin et al. (2001), indicating the occurrence of self-other bias when explaining responses to a set of ambiguous stimuli (in a sense, to a "projective test"), one could argue that such asymmetric assessments might also occur when evaluating the diagnosticity of biosignals such as heartrate. In fact, people might show a similar asymmetric assessment of the degree of disclosure of their own biosignals relative to the biosignals of their peer, as they do when assessing valanced trait adjectives (Brown, 1986), behavior (Malle, 2006), and idiosyncratic word completions (Pronin et al., 2001). Namely, there are considerable similarities between shared biosignals and the word-fragment completions studied by Pronin et al. (2001). Firstly, biosignals can also be classified under observable manifestations of the self, revealing intimate, naturally covert physiological information. The existing literature generally indicates that people generally perceive these overt words and deeds as more revealing of others than themselves (Andersen, 1984; Andersen & Ross, 1984). Secondly, as for word-fragment completions, the meaning of biosignals is ambiguous (Howell et al., 2016; Liu et al., 2017b), implying its potential interpretations vary widely across different contexts (Merrill & Cheshire, 2016; Slovák et al., 2012). Accordingly, we strongly consider the possibility that intimate biosignals could also give rise to the emergence of self-other bias.

The potential occurrence of self-other bias has so far not been investigated in the context of biosignal sharing. However, such impressions about the self and the other obviously play an important role in the way that people communicate with each other during everyday social interactions (e.g., Goffman, 1978). For instance, people often feel as if their behavior has been misinterpreted or that their character and motives are being misperceived, while they insist that their "outsider perspective" affords them insights about other people that they denied by their defensiveness, egocentricity, or other sources of bias (Pronin et al., 2001). These perceptions partly determine how much time and energy we devote to discerning and correcting others' impressions about us, as opposed to testing and correcting our own impressions about others. Such convictions can make us reluctant to take advice from others who are unaware of our private thoughts, feelings, interpretations of events, or motives. On the other hand, these beliefs make us all too willing to give advice to others based on our perceptions of their past behavior, without adequately considering their thoughts, feelings, interpretations, and motives (Pronin et al., 2001).

The current study enables us to better understand how people interpret shared biosignals, and to what extent this influences our perceptions and inferences about ourselves and others. These insights will hopefully bring us one step closer to achieving a comprehensive understanding of shared biosignal interpretations altogether. Reaching this goal could be a valuable addition to society as a whole and specific fields such as mental healthcare.

Factors potentially affecting the self-other bias

The literature suggests a number of factors that may be of particular importance in the occurrence of the self-other bias when deriving intimate information from shared biosignals, which will therefore be included in the study as control variables. The most common ones are the perceived similarity to the other participant, the perceived valence of the stimulus being attributed, and personal preference or tendency to think in a more rational/intuitive fashion.

Pronin et al. (2001) already suggested that the intimacy of the relationship has a moderating effect on the self-other bias. Other studies also suggests that asymmetric insight might actually be less likely to occur among friends than among individuals who are not linked by close friendship. Specifically, intimates or close friends have proven more likely than non-intimates both to agree in their perceptions of each other (e.g., Funder & Colvin, 1988; Kenny & Kashy, 1994; McNulty & Swann, 1994) and to be blind to each other's negative qualities (e.g., Murray & Holmes, 1994; Taylor & Koivumaki, 1976). Although the available literature regarding the role of perceived similarity in making interpersonal biosignal judgments is fairly limited, the results do suggest that perceived similarity to the other participant might affect people’s judgment about the degree of diagnosticity of other people's signals, and thus the occurrence of self-other bias.

As was briefly touched upon before, the effect of the perceived valence of a response is also regularly mentioned in studies on self-other bias in perceived diagnosticity ratings. Even though the social meaning of biosignals is ambiguous (Howell et al., 2016; Liu et al., 2017b), several studies suggest that people do assign a certain value to it. For instance, studies have revealed that, when individuals believe that their heartrate is elevated, they tend to make negative inferences about mood and emotion (e.g., Young et al., 1982). In line with prior works’ findings regarding interpretation of one’s own heartrate, individuals significantly rated acquaintances with elevated heartrate as more anxious, more easily upset, and less calm than those with normal heartrates (Merrill & Cheshire, 2016). Interestingly enough, the study conducted by Pronin et al. (2001) which we are replicating, did not specifically investigate whether the self-other differences were more pronounced for judgments involving negatively, neutrally, or positively perceived word completions. However, the theoretical valence effect which is often mentioned in the existing literature highlights the importance of including perceived valence of the shared biosignals as a control variable in the current study. Additionally, including perceived valence as a control variable will also allow us to investigate what happens if the biosignals, against our expectations, were to be perceived as positive. According to the arguments provided by Malle (2006) regarding self-other bias in performance attributions (i.e., actor-observer bias), this might in fact reverse the direction of the bias. The self-other bias as it was first proposed by Brown (1986) in fact already incorporated this valence effect, because the results suggested that only positive attributes were rated as more descriptive of self than of others, whereas negative attributes tend to be rated as less descriptive of self than of others. Because people would in this case see the biosignals as either advantageous or socially desirable, they will in all likelihood rate the biosignals as very revealing of themself and not so revealing of the other person.

Lastly, research on information processing has devoted much attention during the last few decades to personal information processing, or cognitive, styles. This interest is related to the growing popularity of Dual-Process Theories (DPT) in which two different cognitive systems are emphasized. The first processing system is quick, unconscious and affect-based, and is referred to as “intuitive”. The second is logical, conscious, slow and reason-based, and is also labeled as “rational” (e.g., Epstein, 1994; Kahneman, 2003). It follows from previous research that people who base their decisions predominantly on system 1 are focused on perceptual features of a task (Kahneman, 2003; Sloman, 1996). These people might be prone to the biases that stem from context-dependent judgments, while focusing on abstract aspects of a problem (using system 2) should protect you against such judgmental biases (Payne et al., 1988, 1993). Therefore, people with a strong personal preference for either rational or intuitive processing may show a self-other bias to a lesser or greater extent, respectively.

The present research

The current study is motivated by one main research question: to what degree people show self-other bias when deriving intimate information from shared biosignals? We are particularly interested to find out to what extent people perceive their own biosignals to be revealing of their personal characteristics compared to other’s biosignals. In addition, a replication of one of the study performed by Pronin et al. (2001) is performed by having the participants furnish and rate some word completions as well. This replication serves as an additional empirical test of whether the self-other bias indeed occurs when making dispositional inferences about word-fragment completions. Above all, this approach enables us to determine whether the self-other bias occurs specifically for the assessment of word completions or if the bias also generalizes to biosignals, thereby allowing us to investigate whether this phenomenon occurs for none, one, or both types of stimuli. Being able to make this comparison also helps us to reflect in depth on the extent to which the interpretation of biosignals resembles the interpretation of word completions, as well as whether there are substantial differences between the inferences people make about the two types of stimuli.

As mentioned before, Pronin et al. (2001) suggested the occurrence of a self-other bias when explaining responses to a set of observable, ambiguous stimuli. Combining these findings with the equally ambiguous nature of heart rate signals (Howell et al., 2016; Liu et al., 2017b) as well as the fact that shared heart rate feedback exposes these naturally intimate signals (Feijt et al., 2021), we hypothesize the self-other bias occurring in the assessment of the shared heart rate signals just as it does in the assessment of word-fragment completions. Therefore, the hypothesis regarding the main research question is as follows:

H1. Participants rate their peer's simulated heart rate signals as more diagnostic of their personal characteristics than their own signals, when rating the other person's signal first.

On top of this, our work will explore the potential role of perceived similarity, perceived valence, and cognitive style in people’s tendency to display a self-other bias when assessing the perceived diagnosticity of shared biosignals about their own and the other’s personal characteristics. These variables are included in order to shed more light on the potential mechanisms by which these interpretations arise. The sub-hypothesis for perceived similarity is as follows:

H2. Perceived similarity is negatively related to the strength of the self-other bias.

Even though we believe that the valences of the own and the other's signal are conditional in determining the strength and direction of self-other bias, for the individual assessments of the own/other signal contributing to the occurrence of the bias we hypothesize that:

H3a. Perceived valence of the own signals positively influences the perceived diagnosticity of the own signal.

H3b. Perceived valence of the other's signals negatively influences the perceived diagnosticity of the other's signal.

Finally, regarding the effect of information processing style, it is hypothesized that:

H4a. An intuitive processing style positively influence the degree of self-other bias.

H4b. A rational processing style negatively influence the degree of self-other bias.

Method

Design

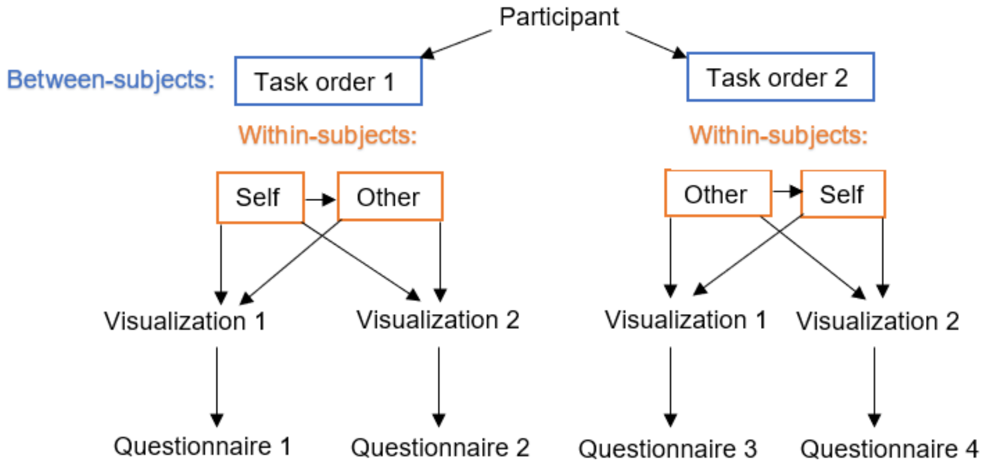
The study involved an online randomized controlled experiment, consisting of two sessions with an intervening period of up to nine days. The content of the first part of the study, in which participants were asked to watch several film clips and record a video of their face, was similar for all participants. The second part of the study had a 2 by 2 factorial design, with feedback type (self vs. other) as the within-subject factor and task order (self first vs. other first) as the between-subject factor. This second part of the study mainly consisted of the perceived diagnosticity measurements of stimuli belonging to the self or to the other. While all participants answered questions both about the self as well as about the other participant, the sequence of these questions was counterbalanced, given that the results of Pronin et al. (2001) revealed an interaction effect involving task order.

Additionally, because we wanted to systematically investigate how people interpret shared biosignals and word completions, the content of stimuli was also manipulated by the researcher. Although the participants were led to believe that they were rating their own and others' signals and completions, in reality they were asked to rate word completions and heart rate signals that were simulated by the researcher. There are two sets of word completions, as well as two biosignal feedback visualizations, which were displayed alternately to the participants within each of the two task order conditions. To illustrate, this meant that a heart rate signal which was presented as belonging to the participant himself to half of the participant group assigned to the first task order, was presented to the other half of the group as belonging to the other participant, and vice versa. This ensured that any potentially significant self-other discrepancies would not be due to (the shape of) the stimulus itself.

In short, while task order varied between subjects, feedback type yielded two repeated measures. Because of the alternation of the stimulus content, there were four variants of the second questionnaire to which the participants were randomly assigned (see figure 1).

Figure 1

Schematic overview study set-up



Note. Visualization of the different questionnaire variants

Participants and Data Collection

The sample consisted of 97 participants (43.3% male, age ranging from 18-74 years, *M* = 24.9), who were randomly recruited through the J.F. Schouten participant database of the Eindhoven University of Technology. In addition to being varied in in terms of age and gender, the sample also proved to be reasonably diverse in terms of background. Participants had obtained either a high school degree (29%), MBO (4%), HBO (5%), Bachelor's (37%), or Master's degree (25%). Furthermore, almost half of the participants (46%) indicated to be not at all or only slightly familiar with measuring heart rate signals whatsoever. About a quarter of them (24%) indicated that they were moderately familiar with heart rate measurements, while the last 30% of the sample reported to be extremely familiar with heart rate measurements. The information processing style did not vary as much between participants, which is reflected in their score on the Faith in Intuition subscale (M= 3.57, SD = .68), as well as on the Need for Cognition subscale (M= 3.63, SD = .68).

The required sample size was determined by conducting an a-priori power analysis, in which the expected effect size was based on the earlier conducted study by Pronin et al. (2001). Completing the effect size formula provided by Rosenthal (1991) with the available data from the article by Pronin et al. (2001) indicated an effect size of 0.39. A simulation in G*power, using the standard significance level of 0.05 and a power of 0.90, indicated a required sample size of 58 participants. Given that effect sizes in the published literature tend to be inflated (biased), the true effect size is likely to be smaller than what is reported in Pronin et al. (2001). Therefore, we decided to also look at the smallest effect size that would be of interest. This would be a medium effect size (d = .30). This simulation resulted in a required sample size of 97 participants, which is the sample size which was ultimately aimed for.

The study ran mid-January until early February 2021 and consisted of two separate online sessions, which had to be completed within a nine-day period. The participants could partake in the two online sessions using their own laptop at a location of their own choice. These two sessions lasted approximately 20 and 25 minutes, respectively. Having access to computer with a webcam and being older than 18 were the inclusion criteria that the participants had to meet. The participants received a compensation of €7,50 for their participation.

Methodological choices

During the research process, some important decisions had to be made regarding the study design and experimental setup, including the addition of a replication part as well as the choice of one type of biosignal.

Heart rate feedback

First of all, a choice had to be made regarding the type of biosignal which would be put under investigation. Out of all conceivable biosignals, we decided to focus on perceived diagnosticity interpretations of heart rate information specifically. The reason to choose this type of biosignal is twofold. First of all, heart rate seems to be a suitable biosignal when it comes to investigating to what extent participants see their own and others' biosignals as being revealing of their personal characteristics. Besides the fact that heartbeat is considered to be a fairly well known and widely approved physiological measures of emotion (Kreibig, 2010), related literature suggests that people tend to associate (their own) heart rate with underlying emotional and psychological states (Slovák et al., 2012). In addition, people usually seem to consider heart rate as an objective signal about one’s state that cannot be voluntarily controlled (Slovák et al., 2012). This corresponds with findings of studies that gave participants false feedback on their own heartrate (Parkinson & Colgan, 1988; Valins, 1966). These studies suggest that people tend to reappraise situations when there is a mismatch between their understanding of the situation and a change in heartrate; when the false heart rate was higher, participants judged themselves as being more aroused (Parkinson & Colgan, 1988). Apparently, people's perceptions of their own emotions and experience are highly influenced by feedback about their heart rate. These findings are particularly relevant for the current study, because the simulated heart rate information is not based on actual physiological measurements and can thus differ greatly from the participant’s actual physiological activity. Despite this, it seems as if participants will be inclined to assume that the heart rate signals will objectively represent their physiological response to the film clips.

Secondly, there is a more practical aspect to this choice. Given that we needed to set up this research as an online study, the use of sensors to perform physiological measurements was out of question, so we had to rely on webcam-related options. To prevent the participants from having any suspicions about the actual purpose of the study, we needed to have a decent cover story regarding the feasibility of extracting their physiological responses from the webcam recording. There are several software packages which enable remote heart rate monitoring by extracting heart rate from video recordings using a technique called remote photoplethysmography (rPPG). FaceReader™ is one of these software tools that has been used widely in studies of facial expressions of emotion and was recently updated to allow for the estimation of heart rate based on rPPG (Castillo, Browne, Hadjistavropoulos, Prkachin, & Goubran, 2020), making this a suitable cover up.

Replication

Furthermore, a replication of one of the studies conducted by Pronin et al. (2001) was added to the present study to help us interpret the significance of our results regarding the occurrence of self-other bias for shared biosignals; instead of only investigating whether or not self-other bias occurs for shared biosignal interpretations, we also checked whether we would indeed find indications that the self-other bias occurs for interpretations of word-fragment completions. This allowed us to infer with more certainty if a self-other bias is present for either or both shared biosignals and word-fragment completions, or not at all.

In order to perform the Pronin et al. (2001) replication, a less extensive variant of the original study was carried out. Instead of conducting individual measurements for all 21 word completions separately, the survey contained only the composite measurement for the set of word completions as a whole. This shortened variant was chosen, because considerable time is saved by omitting the copying and evaluating the individual items. As a result, the time that would otherwise be spent on performing the individual assessments of the completions, could now be spent on measurements which benefited the current research even more. Additionally, the researchers found similar significant effects in terms of self-other discrepancy for the composite rating (i.e., combined assessments for the 21 individual items) as for the separate items. Comparable effects were also found for more global assessments concerning the amount the entire set of completions revealed about the respondents' motives, thinking, and about the respondent overall.

Materials and measures

The study comprised two separate sessions with an interval of up to nine days. Other than a laptop with internet access and a compatible webcam, there were no further materials needed to perform this study. Per session, the different measurements that have been carried out will be presented and elaborated on in the following paragraphs. The survey platform LimeSurvey was used to perform these measurements. The collected data was stored in an encrypted Research Drive folder to guarantee safe data storage.

Part 1

To conduct so-called heart rate measurement, participants watched three short film clips while simultaneously recording their face.

Film clips. The series of clips started with a neutral video (i.e., images of an aquarium), supposedly as a baseline measurement. The 1-minute clips were then played consecutively, with a 15 second intervals during each clip which a neutral image was shown. The three film clips displayed thunder and lightning, a free running competition, and little lamb running around in the meadow respectively. We deliberately opted for film clips which do not cause an obvious emotional response, instead of film clips in which a certain strong emotional reaction can be expected. This choice was made to match the corresponding biosignal stimulus as closely as possible with the unknown meaning that people assign to the ambiguous word completion stimuli.

To measure their personality and their emotional reaction to the film clips, participant completed the Self-Assessment Manikin (SAM; 3 items; Bradley & Lang, 1994), a short version of the The Big Five Inventory (BFI-2-XS; 15 items; Soto & John, 2017a), and the rational experimental inventory (REI-short; 10 items; Norris, Pacini, & Epstein, 1998).

SAM. The Self-Assessment Manikin (SAM), developed by Bradley and Lang (1994), measured three aspects of participants' emotional experience during the film clips on a Likert-type scale, namely; emotional valence, arousal and dominance. The SAM depicts five illustrations on each aspect of emotional experience; from happy to sad (1-5), from aroused to relaxed (1-5) and from submissive to dominant (1-5). Dominance was not measured, because it is not a relevant factor in the present study. To further clarify the meaning of the pictures, this questionnaire was accompanied with the sentence; "Choose the picture that best depicts how much pleasure/active you feel after watching the film clip".

BFI-2-XS. The Big Five Inventory–2 (BFI-2; Soto & John, 2017b) is a 60-item questionnaire that assess the Big Five personality domains: extraversion, agreeableness, conscientiousness, negative emotionality, and open-mindedness. The 15-item version of this questionnaire (BFI-2-XS) was chosen for this study, because the Big Five is not our main measurement, contrary to what we tell the participants. Furthermore, this short version was found to retain much of the full measure's reliability and validity at the level of the Big Five domains (Soto & John, 2017a). Examples of the statements include "Has little interest in abstract ideas" and "Assumes the best about people". Participant were asked to select a number next to each statement to indicate the extent to which you agree or disagree with that statement. All items were rated on a 5-point Likert scale ranging from 1 (*do not agree at all*) to 5 (*agree completely*).

REI-short. The Rational-Experiential Inventory (REI; Epstein, Pacini, Denes-Raj, & Heier, 1996) is a questionnaire that assesses personal preferences for information processing. Theoretically motivated by Cognitive-Experiential Self-Theory (CEST; Epstein, 1994), the various versions of the REI distinguish between two cognitive styles. The first one is a rational style, measured by an adapted Need for Cognition (NFC) scale (Cacioppo & Petty, 1982), which emphasizes a conscious, analytical approach. The second experiential style, measured by the Faith in Intuition (FI) scale (Epstein et al., 1996), emphasizes a pre-conscious, affective, holistic approach. The 10-item scale (REI-short), used in this study, was developed by Norris et al. (1998). Each scale is divided into five statements respectively for NFC and FI. All items were rated on a 5-point Likert scale from 1 (*completely false*) to 5: (*completely true*). An example item from the rational scale is "I don't like to have to do a lot of thinking (NFC), while the experiential scale for example includes "I believe in trusting my hunches" (FI). In the present study the Cronbach's alpha for the rational scale was .70, and .76 for the experiential scale.

Part 2

Shared biosignals task. In this second part of the study, the main aim was to find out how much people think their own and others' biosignals (see appendix A) reveal about their personal characteristics. The difference between these measurements served as a measure of the degree of self-other bias that a person exhibits. These "perceived diagnosticity" questions were essentially identical to the questions asked in the study by Pronin et al. (2001). Participants were asked to rate how revealing their heart rate during each of the three fragments was, using 7-point Likert scales (anchored at *not at all revealing* to *very revealing*). After completing these individual ratings, they were also asked to answer three more general questions requiring them to indicate me," about "what sorts of things [they] think about," and about them "overall" (in each case using a 7-point Likert scale anchored at *not very much* and *a great deal*). Finally, they were asked to write anything that occurred to them about what the heart rate signals might reveal about "who [they] are and what [they] are like as a person. They were asked to answer the same questions for the (manipulated) heart rate signal of another participant in the study, either before or after assessing their own signal, depending on their assigned condition. Afterwards, all participant received some questions about the perceived similarity to the other participant and the perceived valence of the biosignals. Perceived similarity was measured with the items "How similar do you think you and the other person are likely to be?" and "How much do you think you have in common with the other participant?" (using a 7-point Likert scale anchored at *not at all* and *a great deal*). Perceived valence was measured by supplementing the statements "I perceived my heart rate signals as..." and "I perceived the heart rate signal of the other participant as…" with an answer options on a 5-point Likert scale, ranging from *completely negative* to *completely positive*.

Word-fragment completion task. Afterwards, the replication of the Pronin et al. (2001) study took place. The participants were asked to furnish 21 word completions and to consider and rate the diagnosticity of those completions. Therefore, similar “perceived diagnosticity” questions were posed as for the previously described heart rate signals, except for the ratings of the individual word completions. This made the replication a slightly less extensive version of the original study by Pronin et al. (2001). Either before or after furnishing and rating their own word-fragment completions, participant were asked to answer the “perceived diagnosticity” questions for the (manipulated) completions of another participant in the study as well. Because the exact completions used in the Pronin et al. (2001) study are not reported in their article, the completions that resulted from a small pilot study (N = 4) were presented in the current study as being the word completions furnished by another participant. These word completions can be found in appendix B. In both cases, the questions about the self and the other person as well as the word-fragment completions and simulated biosignals itself, were being counterbalanced. Afterwards, all participant again received questions about the perceived similarity to the other participant and about the perceived valence of the word completions. Lastly, questions about some demographics as well as about the estimated objective of the study were posed.

Procedure

Part 1

The link to the first questionnaire was included in the invitation email sent to a random selection of those registered in the J.F. Schouten participant database of the Eindhoven University of Technology. After signing a consent form (see appendix C), participants received an introduction to the study, which can be found in appendix D. Subsequently, participants were asked to look at the series of emotionally ambiguous film clips, while simultaneously recording a video of their face. They then uploaded this video to an encrypted folder on a dedicated ResearchDrive. After watching the movie and simultaneously recording their face, participants were asked to complete the SAM (Bradley & Lang, 1994), the BFI-2-XS (Soto & John, 2017), and the REI-short (Norris et al., 1998). The accompanying text told the participants that these questions focus on their experience while watching the film clips and about who you are as a person, because we are looking for correlations between your physiological response and their experiences of emotions and personality. Finally, we asked the participants to enter their email address, telling them this would ensure that they will receive the data associated with your own recording. In fact, we collected the email addresses to randomly assign the participant to one of four conditions for the second part of the study. Afterwards, the participants were thanked for their effort so far. They were told that they would receive the invitation for the second and last part of this study within a day or two, after the researcher had analyzed their recordings.

Part 2

Once the researcher has processed the face recordings, supposedly deriving the participant's biosignal information from this footage, the participants received an invitation in the mailbox to complete the second part of the study approximately two days later. They received a link, directing them to the second part of the questionnaire, corresponding to the specific condition to which they were assigned. The e-mail also contained the request to complete this second questionnaire within one week. The second session started with measuring shared biosignals interpretations, which involved presenting the participants a simulated visualization of their own biosignals as well as the biosignals of the fictitious other participant in the study. To introduce this task, the participant received another instruction (see appendix D). Afterwards, several questions about how revealing these shared biosignals are of their own and others' personal characteristics were posed, which in reality concerned our main measurement. As described in the ‘materials and measures’ section, these questions were similar to the “perceived diagnosticity” questions from the article by Pronin et al. (2001). The participants assigned to one task order (N = 48) were asked to rate the perceived diagnosticity of their own heart rate feedback first, while the participants assigned to the other task order (N = 49) were asked to start this task by rating the diagnosticity of the heart rate feedback of another participant. Afterwards, all participants completed the “perceived similarity” and “perceived valence” questions.

In order to perform a replication of the study by Pronin et al. (2001), the study continued with furnishing and rating the word completions. All participants again received an instruction (see appendix D). The participants in the first task order group (N = 48) were asked immediately to furnish a series of completions. They were told specifically that, "we ask that you write the first word that comes to your mind, and then move on to the next item," and "none of them should take more than 15 seconds." When they had furnished the relevant completions, they were thanked for their effort and invited to consider and rate the diagnosticity of those completions. The participants in the second task order group (N = 49) were asked to start this task by rating the perceived diagnosticity of the completions of another participant in the study. Only then they were instructed to furnish and afterward rate a series of completions themselves. Within these two task orders, the stimuli themselves were also counterbalanced, as has already been discussed in the aforementioned design of the study. All in all, participants completed one of four different versions of the questionnaire. Once again, the participant completed the “perceived similarity” and “perceived valence” questions, this time focused on the word completions. Some questions on demographics, and the estimated objective of the study were posed next. The study ended with participants providing they bank details, in order to receive the monetary compensation for completing the study. Participants were thanked for their participation in the study. They were also informed that they will receive a final email with a debriefing shortly thereafter. Last, participants were debriefed and received their monetary compensation. The entire procedure lasted approximately 45 minutes; 20 minutes for the first part and 25 minutes for the second part.

Data analysis

The statistical software packages Stata (StataCorp, 2015) was used in order to conduct this data analysis. Before any statistical tests could be carried out, the datasets exported from LimeSurvey were structured, merged, and cleaned up to create a well-organized and uncluttered dataset. The merged dataset was checked for missing data by removing unfinished surveys from the dataset. Furthermore, several new variables were created. For instance, a variable to define the between-subject variable was generated, indicating the order of the questions about the self and the other. This variable allows us to detect a possible task order effect, which has been suggested by Pronin et al (2001). Participants' scores on the self-report scales included in the survey, including the Rational-Experiential Inventory and The Big Five Inventory, were then calculated as well. Lastly, the difference score (self vs. other) for all individual dependent measures was calculated.

After preparing the collected data for analysis, various descriptive statistics (e.g., age, gender, etc.) as well as some basic analyses that help us to better understand our dataset were examined. To test the main research question, non-parametric Wilcoxon signed-rank tests were conducted for each pair of within-person ratings (i.e., self vs. other)[1]. These mean-comparison test allowed us to determine whether the mean difference between paired observations in the dataset (i.e., self vs. other) is significantly different from zero, which

[1] We choose to report the non-parametric tests, because some dependent variables met the normality requirement while others did not, and transformations yielded no improvement. Furthermore, both parametric and non-parametric tests provided similar results.

provides insight into whether or not we find evidence in this dataset for the occurrence of the self-other bias.

To investigate the role of task order as well as other potential covariates in the occurrence of the self-other bias, such as gender, age, perceived similarity to the other participant, perceived valence of the stimulus, and the rational-experimental information processing, both simple linear regression (SLR) as well as linear mixed models (LMM) were utilized. This last method is a powerful and particularly suited choice for this clustered data, given that it allows between-subject and between-item variance to be estimated simultaneously (Baayen et al., 2008; Kliegl et al., 2011). Therefore, the potential interaction effect including task order, as well as the effects of age, gender, perceived similarity, and cognitive style are studied using a mixed model.

The effect of perceived valence, however, is most informative when including the separate assessment of the own signal, that of the other, or the difference score between the two assessments, as the dependent variables in three linear regression models. Logically, it would make sense if the perceived valence of the own signal has a certain effect on the assessment of their own signals, while the perceived valance of someone else's signal could have an effect on the assessment of their signal, so this was tested in two separate regression analyses with the diagnosticity of own biosignals and the diagnosticity of the other's biosignals as dependent variables respectively. In addition, the effect of valence on the occurrence of self-other bias was studied by fitting a linear regression model including the average difference score as a dependent variable, representing the perceived diagnosticity about the other person minus the perceived diagnosticity score about the self, as the dependent variable.

Results

Participant flow and missing data

Of the 101 participants who fully completed the first questionnaire, 4 didn't complete the second questionnaire due to voluntary drop-out after the first part or non-response to the second invitation. No data was missing for the remaining 97 participants, except for two people failing to answer a couple of open-ended questions. We also evaluated the reliability of the measurements by checking the variance in participants' responses, but we found no cause for concern (e.g., consistently choosing only the extreme values at the endpoints of the scale).

Statistical analyses regarding study set-up

To begin with, some preparatory analyses were carried out, providing information about which dependent variables to include in the subsequent analyses required to answer the main and sub-questions.

Between-film clip differences in perceived amount revealed

Paired samples t-tests were used to investigate whether the perceived amount revealed differed between the physiological responses to the three film clips. Participant indicated that the amount revealed by their own responses to the three clips were not significantly different ($p > .05$). However, the other's response to film clip 1 (M = 3.65, SD = 1.63) was just about significantly more revealing than their response to film clip 2 (M = 4.08, SD = 1.72), $t(96) = -2.12$, $p = .04$, whereas the mutual differences with clip 3 were not statistically significant ($p > .05$). Furthermore, for the interpretation of the own signal, the mean of these three individual items was not significantly different from the composite ratings that combined assessments for the three individual parts of the signal, $p = .33$. For the interpretation of the others' signal, the mean of these three individual items was not significantly different from the composite ratings as well, p = .97. Therefore, only the composite rating of the three individual items (i.e., related to the three film clips) as well as the global assessments concerning the amount the entire set of completions revealed about the respondents' motives, thinking, and about the respondent overall were included in the remainder of the analyses for reasons of simplicity.

Between-item differences in perceived amount revealed

Given the pursuit of simple and clear regression models, Cronbach's alpha was used to check whether all separate diagnosticity measurements could be merged into three mean perceived diagnosticity scores. The three scores represented the average perceived diagnosticity score of the stimulus about the self, about the other participant, and the difference between both. This meant only three regression models would have to be fitted, instead of well over 20 different models when interpreting all perceived diagnosticity items individually. Based on this analyses, we limited ourselves to including only these three mean perceived diagnosticity scores as a dependent variables in the remainder of the analyses instead of the individual perceived diagnosticity items.[2] This contributed to a higher model significance, as well as maintaining a better overview of the results.

Statistical analyses regarding the main research question

Quantitative self-other differences in perceived diagnosticity of shared biosignals

Wilcoxon matched-pairs signed-ranks tests were used to test the hypothesis that participants rate their peer's simulated heartrate signals as more revealing or diagnostic of their personal characteristics than their own signals. Contrary to our expectations, these self-

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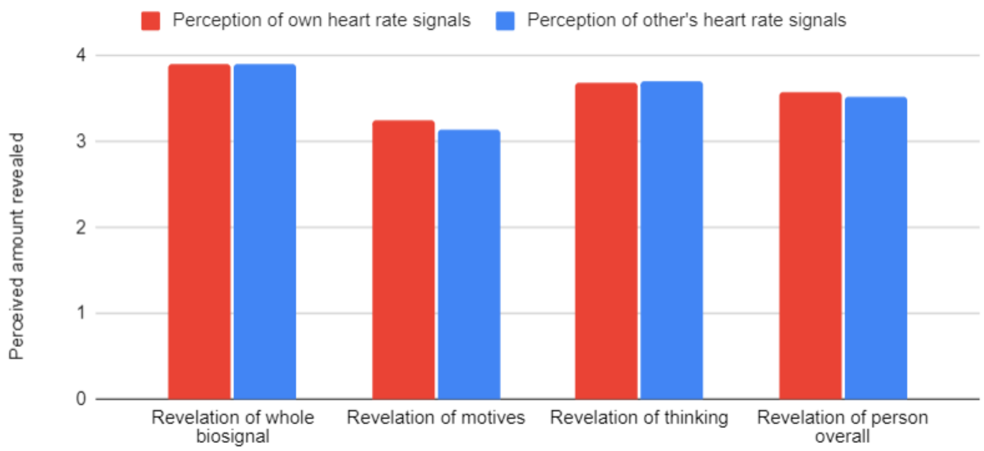
[2] Cronbach's alpha internal consistency measurement substantiated combining the individual items for the self and the other (all $\alpha > 0.88$) as well as for the difference score ($\alpha > 0.70$)

other discrepancies didn't prove to be significant for any of the individual items (see figure 2), with all p-values > .05.

Figure 2

Self-other differences in perceived diagnosticity of shared biosignals



Note. Mean perceived diagnosticity of self vs. other per question

In the subsequent LMM analyses the average perceived diagnosticity of the shared biosignals was included as the dependent variable. Feedback type (self vs. other), task order (self first vs. other first), and the interaction between these two predictor variables were included in the regression equation as fixed factors. Participant ID was included in the model as the source of random variability. The LMM didn't reveal any main or interaction effects involving task order ($p = .50$) or feedback type ($p = .76$) for this type of stimulus. The model thus indicates that the perceived amount revealed by your own biosignals ($M = 3.77$, $SD = 1.30$) versus the perceived amount revealed by the other participant's biosignals ($M = 3.71$, $SD = 1.20$) was not significantly different ($p > 0.05$), not even within a certain task order. These results reject the hypothesis that participants rated their peer's simulated heartrate signals as more revealing or diagnostic of their personal characteristics than their own signals.

Qualitative self-other differences in perceived diagnosticity of shared biosignals

Participants' own open-ended responses also revealed only modest differences in the assessments of the perceived diagnosticity of the own biosignals versus the biosignals of the other participant about stable dispositional traits. Participant did seem to indicate that their heartbeat feedback does say something about, for example, their interests, emotions, and things they get excited about. On the other hand, participants expressed a general reluctance to make inferences about personality traits that go beyond, for example, being a calm person, a caring person, etc. Additionally, the inferences that can be made based on these heart rate signals, as well as the doubts participants expressed about the inferences about personality that can be made based on heart rate only, were usually reported for their own signal as well as for the other person's signal. In that sense, little distinction regarding the perceived diagnosticity of the signals seemed to be made between the assessment of one's own signal versus the signal of the other participants. For instance, when reflecting on the other's signal, one participant responded: “I don't think it reveals much to be honest. Maybe how aroused they are at this moment, but that is only one factor determining emotions”. About the own signals this participant said: “Same as with other person, it is measuring arousal, which does not equal emotions or long-term characteristics in my opinion”. Appendix E contains more written evaluations of participants' own versus their partner's shared biosignals.

Statistical analyses regarding the sub-questions

Effect of valence on the self-other bias for the shared biosignals

First of all, simple linear regression has been used to investigate the effect of valence on the assessments of both one's own and other people's signals. The models indicated that the perceived valence of the shared biosignals might play a role in the occurrence of the self-other bias. More specifically, a strong positive effect of valence of the own biosignals on the mean perceived diagnosticity score for their own biosignals was found ($\beta = .59$, $t(95) = 3.42$, p = .001). This means that the more positive participants perceive their own biosignals, the more revealing they found them. We also found a close to significant positive effect of valence of the other's biosignals on the mean perceived diagnosticity score for their biosignals (β = .32, t(95) = 1.80, p = .08). Both effects are visualized in Figure 3.

This regression model also included valence as a predictor to determine its effect on the average difference in perceived amount revealed between the assessment of one's own heart rate signal and that of the other, representing the degree of self-other bias. This analysis showed that perceived valance difference score had no significant effect on the strength of the self-other bias, with both p-values > .05. In other words, even though the perceived valence of the own signal had a significant positive effect on the perceived amount revealed by the own signal, apparently this did not trigger the occurrence of a self-other bias.

Figure 3

Effect of perceived valence on the mean perceived diagnosticity by participant's own versus another participant's shared biosignals

Note. "ns" indicates non-significance (p > 0.05), whereas the "***" indicates a significant effect of perceived valence of the own heart rate signals (p < 0.001) on the perceived amount revealed about the self

Effect of the remaining covariates on the self-other bias for the shared biosignals

The potential effects of the other covariates which could potentially affect how revealing you find the shared biosignals, including age, gender, perceived similarity, and the rational-experimental information processing style, were evaluated using a mixed model. The model did not suggest the existence of any statistically significant effects of age, gender, perceived similarity, or cognitive style on the perceived amount revealed, with $p > .05$ for all of these variables. Even though the Wald test indicated that all the fixed effects combined are not statistically significant ($p = .\ 0.10$), the Likelihood ratio (LR) test did indicate that the random intercept variance was significantly greater than 0, $p < .001$. This suggested that even though the explanatory variables did not explain a statistically significant portion of the variance in de dependent variable, the mixed model did have a higher goodness of fit than a simple linear model.

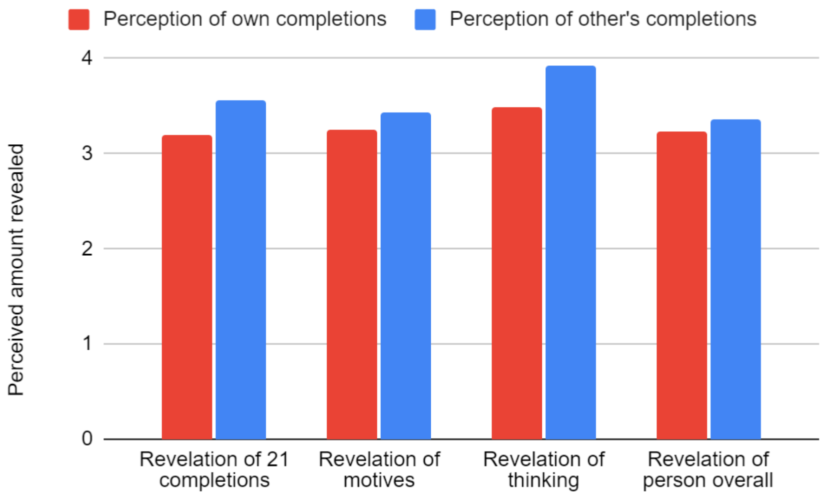
Statistical analyses regarding the replication of the word-completion task

Quantitative self-other differences in perceived diagnosticity of word completions

To perform the replication, we also conducted Wilcoxon matched-pairs signed-ranks tests. Thereby we could test the hypothesis that participants rate their peer's simulated word completions as more revealing or diagnostic of their personal characteristics than their own completions. As opposed to the results found for the biosignals, the self-other discrepancy regarding the word completions proved to be significant for composite ratings that combined assessments for the 21 individual items, $r(96) = -2.74$, $p = .007$, as well as for the global assessments concerning the amount the entire set of completions revealed about the respondents' thinking, $r(96) = -2.61$, $p = .01$. Figure 4 illustrates the predicted tendency for participants to rate their peer's fragment completions as more revealing or diagnostic than their own.

Figure 4

Self-other differences in perceived diagnosticity of word-fragment completions



Note. Mean perceived diagnosticity of self vs. other per question

Subsequent LMM analysis show a similar but slightly more nuanced picture of the word completion results; the model also showed a significant positive main effect of feedback type (β = .14, z(86) = 2.76, p = .006). Interestingly, the model also revealed a significant interaction effect involving task order (β = .18, z(86) = 3.60, p = .001); only if participants first rated the other person's completions before providing and rating their own, participants found the other's simulated word completions (*M* = 3.82, *SD* = .17) significantly more diagnostic than their own completions (*M* = 3.19, *SD* = .19), t(48) = -4.22, p = .001. Figure 5 visualizes the predicted tendency for participants to rate the perceived amount revealed by their peer's fragment completions differently than the perceived amount revealed by their own completions in each task order. These findings replicate Pronin et al. (2001)'s findings that participants rate the other's word completions as more diagnostic of their personal characteristics than their own completions, when rating the other person’s completions first.

Figure 5

Perceived amount revealed by participant's own versus another participant's word completions

Note. Mean perceived diagnosticity about personal characteristics per task order

Qualitative self-other differences in perceived diagnosticity of word completions

Just as the results of Pronin et al. (2001) show, participants' own open-ended responses here too suggested that even though they though the other person's responses were revealing of their personal characteristics, they saw their own responses as determined by the situation and relatively undiagnostic. Their own responses, they felt, had either been caused by prior exposure or demanded by the way the word-fragment stimuli were set up. Even though participants generally indicated they found it difficult to make inferences about the other person’s personality based on word completions alone, they nevertheless seemed more likely to make inferences about someone else's personality based on their word completions than about their own. For instance, one participant commented on the own completions that “Some words were influenced because I read the other persons words first, that made me simply copy them. Overall, I have very basic words that could easily be influenced by my environment, but I personally do not see a clear overlapping that could reveal anything about me as a person". About the completions of the other person, this participant said "They have some interesting word choices, such as PAIN, GOLD, ATTACK, BEAT, SCORE. This would tell me that they might be gaming a lot." Appendix E contains more written evaluations of participants' own versus their partner's word completions.

Effect of the covariates on the self-other bias for the word completions

In the same vein as for the biosignals, the linear regression analyses indicated positive effects of valence of the own word completions ($\beta = .67$, $t(95) = 4.15$, $p < .001$) as well as the valence of the other's word completion ($\beta = .40$, $t(95) = 2.32$, $p = .03$) on the mean perceived diagnosticity score for the word completions. These results shows that the more positive participants perceive the word completions, the more revealing they find it. However, valence did not have a statistically significant effect on the average difference between the assessment of one's own stimulus and that of the other ($p > .05$), as was found for the biosignals. The effect of the other covariates, including age, gender, perceived similarity, and the rational-experimental information processing style, were tested using the linear mixed model. The results of the mixed model analysis show that none of these covariates had a statistically significant effects on the perceived amount revealed, with $p > .05$ for all of these variables. Merely the effect of perceived similarity almost reached statistical significance, $\beta = .25$, $t(95) = 1.88$, $p = .06$.

Additional exploratory data analyses

To put the divergent findings for the biosignals and the word completions into context, the two stimuli were compared on a number of aspects listed below. This stimulus comparison yielded some interesting findings that are worth elaborating on.

Perceived amount revealed

Regarding the interpretation of their own stimuli, people found that on average their own shared biosignals (*M* = 3.77 , *SD* = 1.30) were more revealing than their own word-fragment completions (*M* = 3.29, *SD* = 1.32) of their personal characteristics, z(96) = 2.74, p = .002). Looking at the interpretations of the stimuli of the other participant, people didn't rate the perceived diagnosticity of the shared biosignals (*M* = 3.71, *SD* = 1.20) different from the perceived diagnosticity of the word-fragment completions (*M* = 3.57, *SD* = 1.36), z(96) = .91, p = .25. Additional regression analysis showed no significant effect of task order on the dependent variable representing the difference between the diagnosticity of the biosignals and the word completions.

Perceived valence

Participants didn't perceive the valence of their own word-fragment completions (*M* = 3.13, *SD* = .77) significantly different from the word-fragment completions of the other participant (*M* = 3.07, *SD* = .78), t(97) = -.57, p = .57. They also perceived their own shared biosignals (*M* = 3.42, *SD* = .73) just about as positive as the shared biosignals of the other participant (*M* = 3.39, *SD* = .69), t(97) = -.32, p = .75. Looking at this data in a different way, these results also indicate that participants perceived their own biosignals (*M* = 3.42, *SD* = .73) as significantly more positive than their own word-fragment completions (*M* = 3.13, *SD* = .77), t(96) = 2.82, p = .006. They also perceived the biosignals of the other participant (*M* = 3.39, *SD* = .67), as more significantly more positive than the other's word-fragment completions (*M* = 3.07, *SD* = .78), t(96) = 3.13, p = .002.

Perceived similarity

On average, participants perceived themselves as significantly more similar to the other participant based on their written word completions (*M* = 3.60, *SD* = .90) than based on the physiological responses (*M* = 3.33, *SD* = .99), t(96) = -2.10, p = .04.

Discussion

The current study is motivated by the fact that intimate technologies such as biosignal-mediated communication play an increasingly important role in our lives. When properly deployed, shared biosignals might facilitate social connection by clarifying and conveying our internal experiences when communicating with others (Liu, 2019), which it critical to both our individual well-being and health (Cohen, 2004). Due to the rise of these new applications, several unanswered questions about sharing biosignals become urgent, for instance regarding the social meaning people construct from shared biosignals. Therefore, this study aimed to find out whether people display a self-other bias when making interpretations about the amount revealed by ambiguous stimuli about themselves and about another person. In that regard, participant's perceived diagnosticity interpretations about the self vs. other of simulated biosignals as well as several word completions were contrasted.

Key findings

None of the self-other discrepancies proved to be significant for the individual biosignal items. The word completions results did indicate significant self-other discrepancies for the 21-item composite as well as for the global assessments concerning the amount the entire set of word completions revealed about the respondents' thinking. Similarly, the linear mixed model results didn't show the relevant asymmetry being present in ratings of self versus other, neither when assessing the other person's biosignals before providing and rating the own biosignals nor when the assessment took place the other way around. This kind of pattern was found in the results regarding the interpretation of word completions.

A qualitative analysis supported the observation that participant seemed fairly steadfast in their convictions about the extent to which a heartbeat can say something about the character of a person. Furthermore, the qualitative results showed that participants were more likely to make inferences about a person's psychological state than they were to draw conclusions about a person's stable dispositional traits. By contrast, the analysis of the open questions regarding the word completions indicated that people generally saw the completions of the other person as revealing of their personality, while they perceived their own completions as situationally determined and relatively undiagnostic.

The additional exploratory analyses suggested that valence may play a role in explaining the perceived amount revealed by the own stimulus and the stimulus of the other person; linear regression showed that valence positively influences the mean perceived amount revealed by both word completions and biosignals, about the self as well as about the other person. The other covariates including age, gender, perceived similarity, and the rational-experimental information processing style do not seem to have any statistically significant effects on the perceived amount revealed, neither for the word completions nor for the biosignals.

Lastly, the stimulus comparison results showed that participant seemed to rate their own biosignal feedback as more positive than their own word completions. Participants also believed that their own and others' biosignal feedback were more revealing of their personal characteristics than the word completions. On the other hand, they rated themselves as less similar to the other participant based on the biosignals than the word completions.

Interpretation of the results

First and foremost, we were unable to demonstrate the self-other bias occurring in the interpretation of shared heart rate signals, although our findings do highlight the occurrence of self-other bias in the assessment of word completions. The fact that the occurrence of the self-other bias was demonstrated, once again, for the word-fragment completions, but not for the shared biosignals, reinforces the idea that the phenomenon of self-other bias as we have conceptualized it is linked to word completion interpretations but not to shared biosignals. The fact the self-other bias could be demonstrated in the assessment of the word completions, namely indicates that the (online) set-up of the current research is indeed capable of demonstrating such an asymmetry, but apparently for only one of the types of stimuli studied.

These quantitative results partially meet our expectations. The biosignal findings contradict our hypothesis H1 that the self-other bias occurs in the assessment of the shared biosignals just as it does in the assessment of word-fragment completions; even though previous studies indicated the resemblance between shared biosignals and word completions in several respects, the generalizability of the self-other bias cannot be demonstrated by the current study. The quantitative results do substantiate Pronin et al.'s (2001) claim that self-other bias occurs in word completion ratings of self versus other when participants rated the other person's completions before providing and rating their own, but not when they rated their own completions first.

Importantly, the qualitative results offer a more detailed picture of the meaning attributed to the biosignals. Participants' responses suggest that, rather than to draw conclusions about a person's enduring personality dispositions based on biosignal information, participants do seem to make inferences about a person's psychological state. These results are in line with the results of Liu et al. (2017b) showing that, to a certain degree, individuals do rely on shared biosignals to form impressions about others. However, their results suggested that participants were more willing to use brain activity visualizations to make inferences about psychological states (i.e., a person's currently experienced emotions or level of cognitive activity) than they were to draw conclusions about a person's stable dispositional traits.

The findings regarding the effects of the included covariates on the inferences people make based on the biosignals also merit comment. Most striking about these results is that the valence of the own biosignals has a significant positive effect on the mean perceived amount revealed about the self. This means that positively perceived biosignals are generally seen as more revealing about the self than neutrally or negatively perceived signals, while a significant effect of valence cannot be demonstrated for the other person. The positive effect of valence on the perceived diagnosticity about the self, confirming hypothesis 3a, is in line with the self-serving bias explaining people’s tendency to attribute only positive events to their own character (Miller & Ross, 1975). Furthermore, the fact that this effect cannot be demonstrated for the assessment of the other person, rejecting hypothesis 3b, does correspond to another basic principle of the self-other bias, which is people’s to rate themselves as better than “typical others” (Brown, 1986). However, there are no indications that the perceived valence also has a direct effect or the occurrence of the self-other bias, because valence did not have a significant effect on the difference score between the two assessments. Thus, the effects of valence on evaluations of the self vs. the other do not support the findings of the meta-analysis by Malle (2006), suggesting that valence will affect the actor-observer bias in the opposite way for evaluations of the self vs. the other. Although the effect of valence on the other person's assessment is not significant, the valence effects do seem to follow the hypothesized pattern, at least for high or low valence scores. However, the separate effects of valence on the individual assessments of one's own signal and that of the other just do not seem strong and varied enough to give rise to a significant self-other bias in any direction.

The remaining covariates did not appear to have a significant effect on the strength of the self-other bias. As a matter of fact, we had no expectations about any effect of age and gender on self-other bias occurrence. However, not being able to find an effect of information processing style and similarity on the degree of the self-other bias is not in line with our hypotheses H2, H4a, and H4b. Contrary to our expectations, no effect of perceived similarity was found on the self-other perceived diagnosticity difference score. These results are inconsistent with the hypothesis that individuals who are somehow connected might be less likely to show asymmetry in the self vs. other ratings (e.g., Funder & Colvin, 1988; Kenny & Kashy, 1994; McNulty & Swann, 1994). The fact that these studies mostly linked intimates or close friends, while the participants in this study are complete strangers to each other, may underlie the nonoccurrence of a perceived similarity effect. Prior works already pointed at the important role of the relationship or context of communication between interactants when investigating the effects of biosignals sharing; providing information about heart rate might lead to different perceptions and interpretations of this information across various dyadic communication contexts and within different types of relationships (Merrill & Cheshire, 2016; Slovák et al., 2012).

Furthermore, we hypothesized that people with an intuitive information processing style would be more likely to show the self-other bias, because previous research suggested that intuitive people were prone to the biases that stem from context-dependent judgments, while people with a more rational information processing style were less likely to show such judgmental biases (Payne et al., 1988, 1993). An explanation for this finding may be found in yet another study examining the relationship between cognitive styles and biases (Syagga, 2012). Their results showed that biases not only influence those that have a more intuitive cognitive style, but also those that have an analytical cognitive style. They claimed that individuals might in fact reach optimal decision making results when using intuitive thought alongside analytic thought. Interestingly, Kottemann and Remus (1988) also suggested that cognitive style does not necessarily predict the heuristics used, but rather the consistency of their use. Specifically, the impact of cognitive style manifested as erratic decisions rather than systematic bias. However, one must also take into account the fact that self-report measurements such as the one we used to measure cognitive style might also be subject to certain biases and limitations themselves. This is a well-known disadvantage of self-report measurements which is difficult to get around.

The within-stimulus comparison results also provide us with some interesting information which help us to understand the different findings for the biosignals versus the word completions. In retrospect, we believe that the relatively high perceived diagnosticity score of the biosignals may possibly be related to the chosen formulation of the questions; using the word “revealing” in itself might cause people to give relatively high ratings to the biosignals, because these are inherently "revealing" because of their intimate nature. The amount revealed by both types of ambiguous stimuli might change if terms such as "diagnostic" or "disclosing" instead of “revealing” were to be used when formulating the questions. The relatively positive assessment of the biosignals can possibly be traced back to the emotionally-neutral content of the film clips. The high pleasure ratings are another indication that the participants may have linked a relatively positive meaning to the biosignal feedback. Contrary to the findings of (Young et al., 1982), suggesting that elevated heartrates can yield negative interpretations about one’s own mood and emotion, the fluctuations in the presented heart rate feedback apparently did not cause any negative perceptions of the signal. The word completions probably did have a more negative connotation, which can be noticed in participants’ open answers as well, because they cited terms such as "aggressive" or "pessimistic". Lastly, the low similarity ratings might be explained by the generic difficulties participant experienced with deducing meaning from biosignals due to its novelty, while they are already used to deducting meaning from written words (Feijt et al., 2021). Consequently, people might have some reservations in making similarity inferences based on the vague representation of a relatively unknown biosignal, while this reluctance may not be there when making inferences based on text.

Implications

The present research seems to refute the existence of self-other bias when making inferences about personal characteristics based on shared biosignals, while it contributes to a growing body of evidence suggesting that people show a self-other bias when making these kind of inferences based on word completions. The most compelling explanation for the present set of findings is that people interpret shared biosignals in a different way than they interpret word-fragment completions. This seems to be reflected in the results of the between-stimulus comparison as well. Especially from the qualitative results, it can be deduced that participant have somewhat different ideas about the social meaning of biosignals than about social meaning of word completions. For instance, based on the word completions, people seemed to attribute character traits such as goal-driven, pessimistic, aggressive, assertive etc. Based on the biosignals, people didn’t seem to provide answers in terms of stable dispositional traits as much as they do based on the word completions. The meaning they ascribed to the biosignals was more focused on a person's affective responses or mental state, such as their experiences or emotional responses while watching the film clips.

These results provide us with a number of interesting theoretical implications. Even though the findings indicate that people do not seem to perceive themselves and others asymmetrically for the type of personal characteristics that we have questioned, they do seem to link different meanings to shared biosignals than to word completions. The fact that people’s inferences in response to the biosignals feedback were mainly based on emotional experiences, rather than on stable dispositional traits, raises the possibility that people would see differences in perceived diagnosticity about another type of intimate information, such as affective responses.

All in all, the occurrence of the self-other bias when interpreting shared biosignals, as it is conceptualized in the current study, seems rather unlikely based on the gathered data. If these findings would hold over time, this would be in favor of deploying shared biosignals to solve the lack of non-verbal cues in mediated social interactions. One of the main concerns regarding the use of biosignals for this purpose is that biases such as the one postulated in the current study might arise, possibly causing misunderstanding. If people are indeed not inclined to make different inferences about the meaning of someone else's signal than about their own signal, this potential drawback would be less of a concern when incorporating biosignals in interpersonal communication systems. However, based on this study alone, it is too early to claim that the self-other bias does not occur for shared biosignals. Biases like this one might still occur, be it a different form or under different circumstances.

Limitations

There are at least three potential limitations that are appropriate to recognize concerning the results of this study. First of all, we considered the possibility that perhaps the cover story, by which the study falls or stands, was not credible enough. Participants might have suspected that the heart rate signals were simulated and not based on actual measurements, given that there were some participants who indicated that they doubted the authenticity of the signals. Also, when answering the question about the true objective of the study at the end of the second questionnaire, a number of participants indicated that they thought the study was actually aimed at comparing the interpretations of your own and other people's signals, rather than inferring their personality based on their heart rate. However, excluding the few participants who discovered this goal from the statistical analyses did not yield any significantly different results. Furthermore, when comparing the two types of stimuli to each other in terms of perceived amount revealed, the significant effects that were found in fact indicated that people believed the shared biosignal to be more revealing than the word-fragment completions of someone's personal characteristics. One possible interpretation of these findings is that people do not by definition doubt the inferences that can be made on the basis of the shared biosignals that we presented to them. If one were to wonder in general whether heart rate can be linked to personality based on the stimuli shown, for example as a result of doubts about the measurement method, this could prevent any asymmetric assessment from emerging as well. However, these quantitative results seem to indicate that people are not less likely to make inferences about personal characteristics based on biosignals, but that they are less likely to do so in an asymmetric manner.

Secondly, even though the original method of Pronin et al. (2001) has been preserved as much as possible, we must consider the fact that we are dealing with a newly developed biosignals stimulus, which does limit the generalizability of our findings to a certain extent. Given that the modality of biosignals is entirely new, and we are still unfamiliar with communicating using physiological information, we are only just starting to understand how social meaning is constructed from the received physiological information. Whereas the two word completions sets from Pronin et al. (2001) were used for the replication part of the study, the film clips as well as the corresponding participants' heart rate feedback had to be designed from scratch by the researcher. Although the signals were considered to be credible by the pilot participants, the possibility exists that other film clips or a different heart rate signal would provoke different participant responses. The study by Liu et al. (2017b) also compared different brain activity representations and found that these significantly influenced participants' inferences; even on the same data, certain features of biosignals visualizations, such as imagery, animation, and amount of information, can produce diverse impressions.

Lastly, it should be noted here that only a small portion of the variation in the perceived amount revealed can be ascribed to the independent variables measured in this study. This limitation is especially applicable to the biosignals results, for which the vast majority of the variation resides at the individual level. Given that the purpose of this study is to understand how perceived diagnosticity interpretations differ between the self vs. other rather than to predict it per se, this is not a major limitation of the study. However, it does indicate that it might be interesting to look for other variables that better explain how these kinds of inferences about intimate information come about.

Future research

Although the present study increases our understanding of ambiguous stimuli interpretations overall, its most important contribution may be that it raises a variety of intriguing questions for future research. To begin with, it would be interesting to study the biosignal inferences that people make about intimate information other than stable dispositional traits. The qualitative results namely show that participant do express certain ideas about affective inferences that can be made based on the feedback, such as the emotions that someone might have experienced during the measurement period. Adding to that, the implementation of biosignals as a novel physio-social cue in mediated interpersonal communication supposedly facilitates social interactions, in which subjective aspects such as emotions and experiences usually play a central role. Besides, the way in which the feedback on physiological measures is presented might result in different interpretation of the same information. Similarly, the film clip content may raise certain expectations about the corresponding heart rate signal. There were several reports of participants who expressed specific expectations they had as to what their heart rate signal would look like. They explicitly compared this expectation to the (simulated) heart rate feedback that was provided to them. Therefore, choosing different biosignal representations or different film clip content (e.g., highly emotional) can also add to our understanding of the kind of inferences that are made based on biosignal feedback, and under which circumstances these inferences do or do not come about. In short, it would be interesting to see if similar research results would be found when using film clips with another type of content, or showing heart rate feedback which takes on a different form.

There are several other factors that seems particularly relevant when moving towards the application of psychophysiology for everyday social interaction purposes. Studies describe various contextual factors influencing people's interpretations, such as the specific situation (Merrill & Cheshire, 2016), the relationship between the interacting parties (Slovák et al., 2012), and previous knowledge and beliefs about physiological signals (Curmi, Ferrario & Whittle, 2017; Liu et al., 2019; Merrill & Cheshire, 2017). Even though some of these factors were touched upon in the current study, they should be investigated more extensively in follow-up research.

Regarding the set-up of this study, it could be of added value for the research field to repeat this study while providing participants with actual physiological measuring equipment (e.g., a smartwatch) instead of relying on so-called remote heart rate measurements. This method would entail two advantages; even if the feedback presented were still simulated, this set-up in itself might increase the credibility of the (simulated) measurements and the subsequent analysis. At the same time, if we would actually be able to conduct real physiological measurements which deliver high quality physiological data, this enables researchers to investigate if the results we found for the simulated heart rate signals hold when genuine feedback about realistic heart rates is provided. While simulating the feedback enabled us to control the differences between the different conditions, real physiological feedback will most likely show much more subtle differences between the signal that were presented as being either your own or someone else's. All in all, there are several other research directions that might be worth exploring in order to obtain a clear picture of how biosignal sharing can best be used to support interventions for bridging understanding with others.

Conclusion

Recent developments in biosensing technologies expand the range of application possibilities for physiological signals, including interpersonal communication via biosignals. One of the fundamental challenges that need to be addressed regarding biosignal sharing concerns the difficulties that people experience in constructing social meaning from the transmitted physiological information. There is still a lot of uncertainty about what we read in our own and others' biosignals, for instance regarding the degree of disclose about our own and others' internal traits or psychological states. Based on the finding from one the studies conducted by Pronin et al. (2001), we hypothesized that making these kind of inferences might give rise to a self-other discrepancy in perceived diagnosticity, known as the so-called self-other bias first documented by Brown (1986). As such, this research aimed to identify the extent to which people show self-other bias when deriving intimate information from shared biosignals.

From our results, it can be concluded that the occurrence of a self-other bias for biosignals, as it emerges for the word completions, is rather unlikely. Our research did replicate the results of Pronin et al (2001), once again pointing out people's tendency to rate their peer's fragment completions as more revealing or diagnostic than their own. In addition, the qualitative results highlighted a difference in the way people construct social meaning from biosignals compared to the word completions. At least, the present study suggests that people's perceptions of the meaning of shared biosignals seems to be focused on someone's affective responses or mental state, which deviates from the dispositional meaning people typically assign to word completions. We also found that the valence of the own biosignal has a strong positive effect on the perceived diagnosticity of the own signal.

Being able to compare the biosignal results to the word completion results, to study participants' qualitative responses, and to examine the effect of valence more closely, has enhanced our understanding of ambiguous stimuli interpretations altogether. Furthermore, the main part of the study concerning the biosignals interpretations, can be seen as a first step towards integrating two lines of research; one focusing on shared biosignals interpretations and the other focusing on the occurrence of self-other bias when making inferences about intimate information. To our knowledge, these research areas have not yet been directly linked before. Even though the current study does not allow us to make a definitive statement about whether or not people make fundamentally different inferences based on their own versus others' biosignals when deriving intimate information, the present study has provided several interesting insights which can guide follow-up research. The suggested follow-up studies will enable researcher to gain a better understanding of the interplay among cognitive, perceptual, and motivational factors in determining when and why individuals are likely to feel differently about the perceived diagnosticity of their responses compared to others' responses, while such differences usually cannot be justified from an objective point of view. Ultimately, we hope that the current research will stimulate further investigation to ultimately establish for which purposes and under which conditions biosignal sharing truly facilitates biosignal-mediated social interactions.

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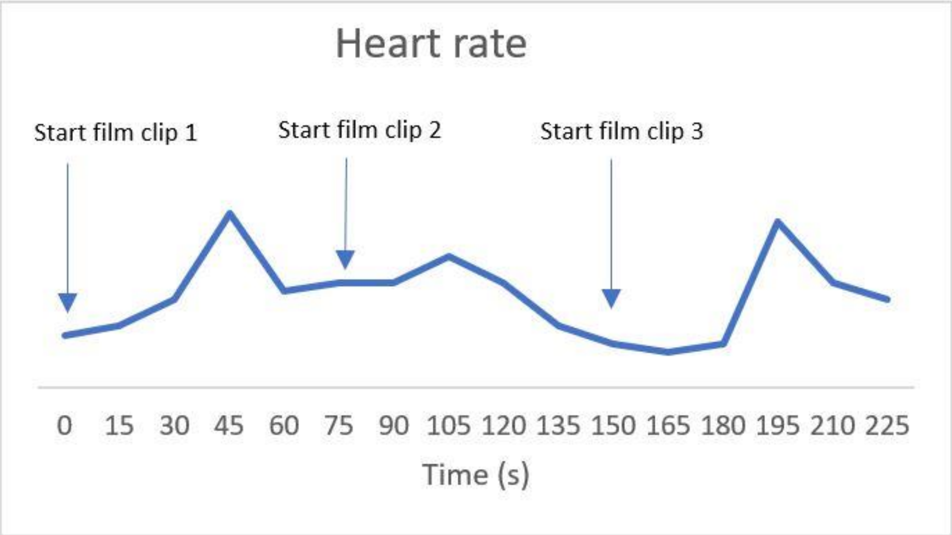
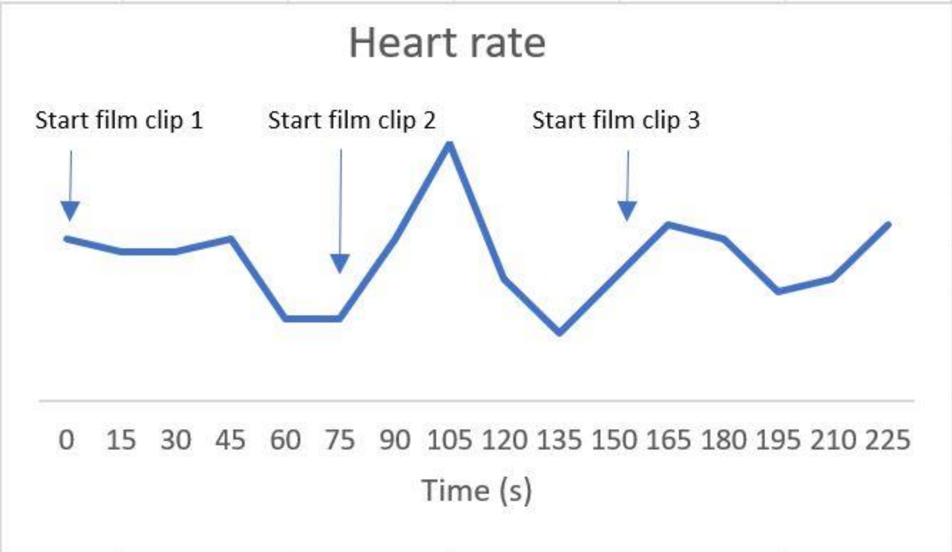
Appendices

Appendix A. Shared biosignals feedback

Heart rate feedback self/other: version 1



Heart rate feedback self/other: version 2



Appendix B. Word-fragment completions

Word-fragments to complete

Set A: G _ _ L, _ _TER, S_ _RE, P _ _ N, TOU_ _, ATT _ _ _ , BO _ _ , FL_ T, SL_ T, STR _ _ , GO_ _ , CHE_ _ , _ _OR, SL _ _ _, SC _ _ _ , _ _ NNER, B_ _ T, PO _ _ _ , BA_ _ , _RA_ , _ _ EAT.

Set B: CRE _ _ _ , S_ _ RT, HO _ _ _, _ _ _ EN, RO _ _ , _ _ TING, ST _ _ _ , _ _ _ VE, B_ _K, _ _EM, G_ _L, _ _TER, S_ _ RE, _EST, STR _ _ _ , _ _NNER, _ _OING, FLO _ _ _, PA _ _, _ AIL, W_R_.

Completions other participant

Set A: GOAL, LATER, STORE, PAIN, TOURS, ATTACK, BOAT, FLAT, SLOT, STREAM, GOLD, CHEAP, DOOR, SLEEP, SCORE, SINNER, BEAT, POSTS, BARE, BRAT, REPEAT.

Set B: CREEPS, SHORT, HOMES, EATEN, ROSE, VOTING, STOOL, STOVE, BOOK, STEM, GOAL, LATER, SHIRE, REST, STREET, WINNER, FLOWING, FLOODS, PASS, FAIL, WORD.

Appendix C. Informed consent form

EINDHOVEN UNIVERSITY OF TECHNOLOGY

Information form for participants

This document gives you information about the study "Biosignals and personality". Before the study begins, it is important that you learn about the procedure followed in this study and that you give your informed consent for voluntary participation. Please read this document carefully.

Aim and benefit of the study

The aim of this study is to measure how differences in personality constructs can lead to different physiological responses when viewing the series of video clips.

This study is performed by Suze Aerts, a student under the supervision of Wijnand IJsselsteijn and Milou Feijt of the Human-Technology Interaction group.

Procedure

You can participate in this online experiment using your web browser. You must also have a webcam at your disposal. This study consists of two parts which are carried out with an intervening period of approximately two days. In the first part, you will be asked to watch a YouTube video and simultaneously record a video of your face using the online recording tool 'Cam Recorder'. This tool uses the built-in recording options in the browser, does not require any installation, and stores the recordings locally on your computer. This means that the recording will only be accessible to people with access to the computer. You can consult the terms and conditions using the following link: https://www.cam-recorder.com/contact.
Furthermore, some additional questions are asked in this first part of the study.
Afterwards, the researcher will analyze your physiological response using Face Reader software. Your heart rate while watching the YouTube video is derived from the recording of your face using Remote Photoplethysmography (RPPG) techniques.
In the second part of the study, your physiological response is presented to you. In addition, we ask you to perform an additional experimental task and answer several related questions.

Risks

The study does not involve any risks, detrimental side effects, or cause discomfort.

Duration

The instructions, measurements and debriefing will take approximately 45 minutes in total. The first part of the study takes about 20 minutes, while the second part takes about 25 minutes.

Participants

You were selected because you are either registered as a participant in the participant database of the Human Technology Interaction group of the Eindhoven University of Technology or because you were personally invited.

Voluntary

Your participation is completely voluntary. You can refuse to participate without giving any reasons and you can stop your participation at any time during the study by closing the web browser. You can also withdraw your permission to use your data up to 24 hours after the experiment is finished. None of this will have any negative consequences for you whatsoever.

Compensation

You will be paid €7.50 or receive course credits only when you complete the entire study. You are asked to provide your student number/bank details at the end of the second and last online questionnaire in order to receive this compensation.

Confidentiality and use, storage, and sharing of data.

All research conducted at the Human-Technology Interaction Group adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen – Dutch Institute for Psychologists), and this study has been approved by the Ethical Review Board of the department.

In this study personal data will be recorded, analyzed, and stored. This data is used to answer the research questions and publish the results in the scientific literature. To protect your privacy, all data that can be used to personally identify you will be stored on an encrypted server of the Human Technology Interaction group for at least 10 years that is only accessible by selected HTI staff members. No information that can be used to personally identify you will be shared with others. The video recordings will not be distributed and will not be played back in the presence of people other than the researchers.

The coded data collected in this study and that will be released to the public will (to the best of our knowledge and ability) not contain information that can identify you. It will include all answers you provide during the study, including demographic variables (e.g., age and gender) if you choose to provide these during the study.

The data collected in this study might also be of relevance for future research projects within the Human Technology Interaction group. In any case, the video recordings will not be used for this purpose. This material will be deleted immediately after being analyzed.

You are free to decide whether or not you want to consent to the use of your personal data for any follow-up research within the Human Technology Interaction group. Unfortunately, if you do not agree with the use of your data for future research, you cannot participate in this study. If so, you can cancel your participation by closing this webpage.

Further information

If you want more information about this study, the study design, or the results, you can contact Suze Aerts (s.m.aerts@student.tue.nl).

If you have any complaints about this study, please contact the supervisors Milou Feijt, MSc (m.a.feijt@tue.nl) or Prof.Dr. Wijnand IJsselsteijn (w.a.ijsselsteijn@tue.nl). You can report irregularities related to scientific integrity to confidential advisors of the TU/e.

Certificate of Consent

By clicking on the button below you agree that you have read and understood this consent form and that you agree to voluntarily participate in this research experiment carried out by the research group Human Technology Interaction at the Eindhoven University of Technology.

Appendix D. Participant Instructions

Introduction to the study

Personality traits can shape the perception and interpretation of a given situation and thus affect someone's reaction to the situation (e.g., Mischel & Shoda, 1995). A recent study by Bizzego et al. (2020) even suggests that differences in personality constructs might lead to different physiological responses when viewing the series of video clips. However, the link between someone's personality and biosignals - i.e., physiological measures such as heart rate, skin conductance, and respiration - is still relatively unclear. In this study, we want to investigate how physiological responses to a set of film clips are related to experiences of emotions and personality traits. In order to do so, we are about to show you a set of film clips while measuring your physiological response. Afterwards, we will ask you some questions about your experience of the video and your personality. To be able to derive your physiological responses while watching the film clips, we ask you to simultaneously record a video of your face using your webcam. The researcher will analyze the video using FaceReader software in order to extract your heart rate. Simply put, this analysis is based on subtle color changes in the face, using remote photoplethysmography (RPPG) techniques.

Introduction to the shared biosignal task

In the first part of the study, you watched a movie clip and simultaneously recorded a video of your face. Afterwards, the researcher has analyzed this video using FaceReader software, which offers the opportunity to deduce the heart rate of a person based on color differences in the face. The heart rate signals of all other participants in this study were also extracted from their recordings in the exact same way. Next, we will present to you the extracted heartbeat information. The researcher uses this information to investigate how your physiological responses to the set of film clips are related to your experience of emotions and your personality traits. We would also like to know to what extent you think your physiological response indeed says something about your personality. We ask for your opinion about the heart rate of another participant in the following questions as well.

Introduction to the word-fragment completion task

If you've participated in other psychological studies, you might have done something like the following task before. It is a pretty common task that psychologists use, called "word-fragment completions". The fragments have all been selected because they have multiple possible completions. The nature of the task is that you write the first word that comes to mind, so it generally goes fairly quickly. One of the reasons why we are interested in the word-fragment completion task is that a long tradition of psychologists have argued that the way people complete these words reveals something about their personality, desires, goals, and motives. At this point, we really do not know whether we agree or disagree with this hypothesis, but it is an intriguing one. In other words, we ask you to perform this word completions task, because the way you complete these words is likely to be yet another indicator of your personal characteristics. As an additional validation of our findings, we would also like to hear what you think about this yourself. Therefore, the following questions focus on the extent to which you think the completed words indeed reveal something about who you are and what you are like. We also ask you about the word completions of another participant.

Appendix E. Open-ended questions responses

Table 1

Participants' interpretations of their own and others' shared biosignals (representative examples)

Participant	Analysis of own completions	Analysis op partners completions
A	I don't think you can tell my personality from these results. I also do not necessarily agree with the results for films 2 and 3. Film 1 did indeed make me restless, and you may see that in the heartbeat. But I don't know whether that says anything about my personality.	I think it only says something about someone's interest. If you are interested in / have a certain relationship with lambs, maybe the heart rate will increase during that video. I don't think it really says anything about someone's personality.
B	The second clip is remarkable, since the heart rate first increases a lot, whereafter it decreases. This may imply that such videos do excite me at first but quickly become somewhat boring as time goes on since it quickly went down.	They are probably somewhat kind and light-hearted since the lamb video triggers a high increase in heart rate response. And might have some experience with thunder, may it good or bad since that also triggered a response.
C	I think that my heart rate has a direct link with my emotion. However, I think that my heart rate was lower during the first clip than depicted :-)	It might give an indication of the emotion.
D	I am quite a calm person and not really a sporty/risky/adventurous type of people, the heart rate signal indeed portraits that in a sense.	this person might be a sporty, adventurous dare-to-do-things person, also loves animals
E	A higher heartrate when I find something interesting	It can indicate what you are afraid of or what you are enthusiastic about
F	The same as in last question; however considering this is my own HR signal, I immediately try to see whether spikes in my heart rate correspond to emotional spikes I may have experienced while watching the videos. The only ones I can really remember was at the start of the	I think few inferences can be drawn on personality and motives from just heart rate. I think that physiological response to videos like these can be telling about the viewer's interests, and to what extent they are familiar with the content they're watching. For instance, I might expect the response

	freerunning video (something I'm relatively interested in) and sometime during the lamb video, where the lambs' behaviour caused me to smile. In the last video, I could imagine a link between my response and my personality (e.g. it may be telling that I enjoy something as silly as lambs running around), but I'm not sure.	of a freerunner to spike upon viewing the second clip (or that of a farmhand seeing the third), and I might expect the response of someone who regularly to be considerably smaller than someone who's never seen it. Although character traits may be related to interests and hobbies and stuff, I doubt much personality information (say, how compassionate, socially dominant, or optimistic someone is) can be directly inferred from this signal.
G	It doesn't feel like this heart rate chart belongs to me, at least it's completely contradictory to how I felt during the movies. I felt excited about the free running clip so I expected a spike there. What's more, I don't understand the spikes in the middle of the first and third clips, since there was nothing extraordinary happening in the middle (as far as I remember).	I think a higher heart rate can be a signal of excitement but also of fear, so all I know is that the person felt either of these two ways during the freerunning video. Their heart rate slowed while watching the thunderstorms, so they're probably a calm person.
H	Same as with other persons, it is measuring arousal, which does not equal emotions or long-term characteristics in my opinion.	I dont think it reveals much to be honest. Maybe how aroused they are at this moment, but that is only one factor determining emotions.
I	I think that the two videos I feel personally connected with (thunderstorm and lambs) show a higher heart rate than the one I don't have any personal connection with (free running). But I am not sure whether that also reflects my personal characteristics. It is just that I get excited when there are thunderstorms and want to watch it, and running lambs make me happy, maybe because I like dogs :)	Now I see this graph and compare it with mine, it is quite different, so I feel it does indeed tell something about the person. That is very cool.
J	I might indicate whether you are a stressful person or not. Or whether you are scared easily or get excited easily. Furthermore, if you love animals the last movie will probably evoke a different response than if	If seems that he/she got excited about the freerunning clip which could indicate an excitement for thrill seeking events perhaps

	you do not particularly like animals	
K	I do not see any connection between the heart rate during the clips and any personality trait	Again I do not see what these clips have to do with personality

Note. Capitalized words in italics are actual completions cited by participant. Capitalized words in brackets are actual completions that were not cited in the participant's account, but are relevant to his or her analysis.

Table 2

Participants' interpretations of their own and others' word completions (representative examples)

Participant	Analysis of own completions	Analysis op partners completions
A	I do not see any relation between the word completions and my personality.	The person seems rather goal driven. But at the same time they also seem easy going.
B	I don't think this random words shows much about who I am and my personality	This person might be following STEM education, smart and interested in politics
C	The most used or practice in day to day life comes as the first word. So, I don't think this reveals about personality. But it can reveal what the person is really thinking right now.	The person is over-thinking, very cautious and fears of negative things. This is the person's feeling at the moment.
D	I guess the first words that come to my mind relate to the things that I have recently thought about. But I don't recognize a pattern that could be matched to my personality, at least not the way I perceive it.	I can recognize a bit of a pattern in the words, like GOAL, GOLD, CHEAP, SCORE, which makes me think of a person who cares much about their social status. Not sure if the person would actually be like that.
E	I don't think it reveals anything about me.	Some words are rather negative, so I could think that this is someone who tends to think in a negative way. However, the word ROSE is, to me, positive. So I think it is hard to say something about who they are and

		what they are like.
F	Some were really difficult to complete so I don't know if it is that representative for me. But maybe that it are all quite positive words and mostly verbs.	More negative words and more extreme words. I would say more a pessimist.
G	Some words were influenced because I read the other persons words first, that made me simply copy them. Overall, I have very basic words that could easily be influenced by my environment, but I personally do not see a clear overlapping that could reveal anything about me as a person	They have some interesting word choices, such as PAIN, GOLD, ATTACK, BEAT, SCORE. This would tell me that they might be gaming a lot.
H	The word completion does not reveal much significance information about who I am	The person should be an aggressive person
I	A personal introspection based on these word completions is harder to do than an outsiders perspective	The person is probably anxious about success and believes in material possessions as a source of happiness.
J	Because you have seen the words completed before you sometimes get proned to use those words.	I think the person wrote down a lot of aggressive words, so the person could be more violent or attacking
K	I initially had a hard time coming up with some of the words, to which I just filled something in - even if I doubted about it being a valid word. That could indicate my levels of openness to experience/creativity, or my low levels of conscientiousness. moreover, I sometimes could stress a bit if I did not know something to fill in, which could indicate my neuroticism. From the words however, I can not really see patterns corresponding my personality.	Seems like someone who might be on the assertive, conscientious side, goal-orientated, black-white thinking, orderly or industrious.

Note. Capitalized words in italics are actual completions cited by participant. Capitalized words in brackets are actual completions that were not cited in the participant's account, but are relevant to his or her analysis.

Appendix F. Summary

Because of recent advancements of biosensing technologies, shared biosignals are suggested as a novel physio-social cue possibly creating new opportunities to bridge understanding with others during our day-to-day social interactions, including biosignal-mediated communication. Although the existing work on shared biosignals identified potential benefits and costs in terms of affective outcomes of biosignal communication, few have addressed the perception of biosignals as useful cues for inferring your own and others' personal characteristics, i.e., its perceived diagnosticity. In order to deploy shared biosignals as a useful source of social information, we first need to find out what people read into our own and others' biosignals, for instance regarding this degree of perceived diagnosticity about our own and others' internal traits or psychological states. Interestingly, various studies focusing on the inferences and attributions we make about ourselves and other people suggest that these perceptions are susceptible to various sources of bias. The specific bias whose occurrence is explored in the current study is the self-other bias, which was first proposed by Brown (1986). The concept of self-other bias, as adopted in the current research, refers to people's tendency to rate their own responses as less diagnostic than those of another person.

Given that previous literature suggests that people might make a similar asymmetric assessment of the degree of disclosure of their own biosignals relative to the biosignals of their peer as they seem to do when assessing valanced trait adjectives (Brown, 1986), behavior (Malle, 2006), and idiosyncratic word completions (Pronin et al., 2001), the aim of the study was to investigate whether this self-other bias occurs in the assessment of the shared heart rate signals. This would mean that the participants, armed with knowledge about their own private thoughts, feelings, motives, and associations, tend to see their own heart rate signals as less revealing or "diagnostic" of their personal characteristics than those of another person. To test this hypothesis, we measured the perceived diagnosticity of the heart

rate signals, and compared self vs. other conditions using paired-samples t-test and subsequent linear mixed model analysis. In order to obtain a deeper understanding of how, what, and why this type of social meaning is constructed from shared biosignals during interpersonal interactions, we also investigated potential effects of perceived similarity to the other participant, perceived valence of the stimulus being attributed, and personal preference or tendency to think in a more rational/intuitive fashion on the strength of the self-other bias. Furthermore, a replication of one of the studies conducted by Pronin et al. (2001) was added to the present study to help us interpret the significance of our results.

The results showed no self-other bias occurring in the assessments of shared heart rate signals, but we did replicate the self-other bias for the word completions. Furthermore, perceived valence of the stimulus had a positive effect on the mean perceived diagnosticity score of the own response only, whereas perceived similarity and information processing style had no influence at all. The fact that the occurrence of the self-other bias was demonstrated, once again, for the word-fragment completions, but not for the shared biosignals, reinforces the idea that the phenomenon of self-other bias as we have conceptualized it is linked to word completion interpretations but not to shared biosignals. In fact, especially from the qualitative results, it can be deduced that participant indeed seem to have somewhat different ideas about the social meaning of biosignals than about social meaning of word completions; people's perceptions and interpretations of heart rate signals may focus more on a person’s psychological state than on their stable dispositional traits. These findings are consistent with the results of Liu et al. (2017b).

All in all, the occurrence of the self-other bias when interpreting shared biosignals, as it is conceptualized in the current study, seems rather unlikely based on the gathered data. However, based on the findings of this study alone it is too early to claim that the self-other bias does not occur for shared biosignals. Biases like this one might still arise, be it a different form or under different circumstances. Even though the current study does not allow us to make a definitive statement about whether or not people make fundamentally different inferences based on their own versus others' biosignals when deriving intimate information, the current study adds value with respect to previous work in the sense that is has enhanced our understanding of ambiguous stimuli interpretations altogether; the main part of the study concerning biosignal interpretations can be seen as a first step towards integrating two lines of research which, to our knowledge, have not been linked before; one focusing on shared biosignals interpretations and the other one focusing on the occurrence of self-other bias when making inferences about intimate information. This study also contributes to a growing body of evidence suggesting that people show a self-other bias when making these kind of inferences based on word completions.

Perhaps the study's most important contribution may be that it has provided several interesting insights which can guide follow-up research. These research directions will allow us to obtain a better understanding of the cognitive, perceptual, and motivational determinants of people's inferences about themselves and others based on shared biosignals. For instance, follow-up research could be conducted to determine if our results hold for real instead of simulated heart rate feedback, another type of film clip content (e.g., highly emotional), differently shaped heart rate feedback, or another type of intimate information (e.g., affective responses). Other factors, such as the relationship between the interacting parties, should also be studied to improve our understanding of when and why individuals are likely to feel differently about the perceived diagnosticity of their responses compared to others' responses, while such differences usually cannot be justified from an objective point of view. Ultimately, we hope that the current research will serve as a stepping stone to establish for which purposes and under which conditions biosignal sharing will truly benefit biosignal-mediated social interactions.