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Physiological linkage among successful high-status women in international teams

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Abstract

In contemporary society, decisions are often made by teams whose members represent different nationalities and genders. In the current work, participants from 55 countries formed groups of 3 to 4 people to select one of the 5 firms in a mock firm search. In all groups, one woman was randomly assigned to have higher status than her groupmates; she was also surreptitiously instructed to persuade her group to select one (randomly assigned) firm. We measured cardiac interbeat intervals for participants throughout the decision-making process to assess physiological linkage—the degree to which a 'sender's' physiological response predicts a 'receiver's' physiological response at a subsequent time interval. On average, high-status women were successful at persuasion. The physiological responses of successful high-status women were also predicted by the responses of their female groupmates: stronger linkage to female group members during the task was associated with success at persuading the group. Successful high-status women were also perceived as more persuasive than others in the group. This work shows that the link between status and successful persuasion generalizes to women among heterogeneous international teams. It also suggests that attention to others—often associated with physiological linkage—may be useful in persuading others during decision-making.

Key words: interpersonal physiology; decision-making; physiological linkage; persuasion; small groups

Physiological linkage among successful high-status women in international teams

Groups are critical for everyday decision-making. Examining physiological processes during group interactions, such as synchrony between group members, can offer unique insight into the automatic processes that underlie group members' behaviors (Mønster *et al.*, 2016; Haataja *et al.*, 2018). Here, we examine the physiology of group members when one high-status woman is trying to persuade the other group members to make a decision aligning with her self-interest. We measure physiological linkage of autonomic nervous system (ANS) responses, which occurs when the physiological response of one group member, the 'sender', predicts the physiological response of another group member, the 'receiver', at a following time interval. We ask the question: is physiological linkage between the high-status member and other group members associated with the high-status member's success at persuading the group? And if so, does the high-status person show physiological linkage to her group members or do group members show physiological linkage to her?

Past empirical and theoretical work suggests that physiological linkage underlies the process of attunement or attention: people show stronger linkage to those they are motivated

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to attend to. For example, in dyadic conversations between African Americans and European Americans, African Americans showed physiological linkage of ANS responses to their European American partners when European Americans displayed nonverbal cues associated with racial bias (appearing tense and uncomfortable; West *et al.*, 2017), which African Americans tend to be particularly sensitive to.

During group interactions, capturing the attention of group members is a critical ingredient for persuasion (Fiske, 2010; Paluck *et al.*, 2016). Thus, it is possible that high-status women who are successful at persuading the group would drive the physiological linkage process; their group members would show physiological to them (i.e. the physiological responses of high-status women who are successful persuaders would predict the responses of their group members).

On the other hand, people who are skilled at understanding the needs of their group members and who adjust their own behavior in response to others are more likely to influence group members and emerge as leaders (Atwater and Yammarino, 1997; Sosik *et al.*, 2002). Thus, it is also possible that successfully persuading the group might result in linkage to others (i.e. the physiological responses of high-status women who are successful persuaders would be predicted by the responses of other group members). We examine both possibilities in the current research.

We also extend work on group processes by examining decision-making in groups that are nationally heterogeneous and have high-status female group members. Modern groups that engage in decision-making are often heterogeneous with regard to national identities, genders, and belief systems (O'Brien and Rickne, 2016; Zakaria *et al.*, 2004), yet scholars have limited knowledge of group processes outside of Western contexts and in heterogeneous teams where people come from different backgrounds (Watson and Kumar, 1992; Arnett, 2008; Henrich *et al.*, 2010). In this study, we test whether women influence decision-making in groups of people from across the world who have been exposed to different amounts of gender equality and, also, whether they interact with other male and female group members in a similar way. Thus, we provide a much-needed extension of group processes and decision-making work beyond typical Western samples.

Current research

We assigned groups of 3 or 4 people from 55 different countries to select one of the 5 executive search firms. Home countries of participants ranged in terms of how much status women have, according to the Gender Inequality Index (GII) from the United National Human Development Program. Within the group, one woman was randomly assigned to a high-status role using a manipulation from past research on social hierarchies (Anderson and Berdahl, 2002; Galinsky *et al.*, 2003) and was incentivized to argue surreptitiously on behalf of a particular search firm. We examine how often the high-status female successfully persuades the group and whether physiological linkage is associated with successful persuasion.

During the group interaction, we measured ANS activity of group members via cardiac interbeat intervals (IBI)—the amount of time in milliseconds between heartbeats. We chose this measure for three reasons. One, IBI is sensitive to quick changes in affect and motivation, which we wanted to capture over time. Two, IBI can easily be acquired from multiple group members simultaneously. Finally, measuring IBI does not require participants to inhibit their speech or movements, which allows for more natural social behavior. Because IBI represents a measure of general autonomic activity, we consider linkage on IBI responses as indicating how much people track changes in the intensity of their partners' physiological states.

We calculated physiological linkage scores for each person in the group that represent how much that person is a sender of their physiological responses to each other group member and a receiver of the physiological responses of each other group member. This approach is idiographic in that we compute separate sender and receiver scores for each person that represent total linkage across the interaction with each other group member. For example, Person A has one 'receiver score' that represents how strongly Person B's IBI reactivity at time interval T-1 predicted Person A's reactivity at time interval T on average, throughout the interaction. Person A also has a 'sender score' that represents how strongly Person A's reactivity at time interval T-1 predicted Person B's reactivity at time interval T, on average, throughout the interaction (scores were calculated by estimating individual-level regression equations, see Method section). Thus, in a group of three people, each person has two receiver scores (e.g. Person A with Person B and Person C) and two sender scores.

Researchers have measured physiological similarity in several ways (see reviews by Palumbo *et al.*, 2017; Timmons *et al.*, 2015). We use the current approach for the following reasons. First, we are theoretically interested in the time-lagged component in which the sender's physiological response predicts the receiver's physiological response at a following time interval. We have theorized that linkage can capture how much people experience physiological changes as a result of being attentive to their partners' behaviors and social cues (see Thorson *et al.*, 2018). The time-lagged element of this measurement contrasts with co-variation models which examine simultaneous physiological responses, which presumably measure how much people share simultaneous psychological experiences.

Second, this approach allows us to adjust for physiological stability (i.e. how much people's physiological responses are predicted by their own prior responses). This is important because stability accounts for a large share of the variance in people's physiological responses at any given time interval. Finally, by creating idiographic linkage scores between each person and each group member, we can test whether physiological linkage is associated with the outcome of persuading group members.

Hypotheses. We expected that high-status women would be more motivated during the task given their more demanding assignment to convince the group to choose a particular firm. As a manipulation check, we examined ANS reactivity of high-status people relative to everyone else, given that ANS reactivity can reflect greater effort and engagement (Obrist, 1981; Wright and Kirby, 2001).

Prior research suggests that groups would be more likely to select firms that the high-status person advocated for than firms not assigned to anyone to advocate for (Berger *et al.*, 1972; Devine *et al.*, 2001; Thorson *et al.*, 2019a). However, it remains to be seen if this effect holds within international teams where participants' countries of origin varied in the amount of female leadership and status, so we explored this question. We did expect, however, that if women were successful at persuading their groups to make a choice in their favor, that their group members would view them as more persuasive than if they were not successful.

We then tested two key questions regarding physiological linkage and successful persuasion by breaking participants into four roles: successful high-status women, unsuccessful

high-status women, other women in the group and other men in the group (referred to as low-status women and men, hereon). We define successful high-status women as those whose groups made a final choice that matched the choice they were assigned to argue for; unsuccessful high-status women are those whose groups made a final choice that did not match the choice they were assigned to argue for. We chose to look at low-status women and low-status men separately on the basis of their gender given that interpersonal processes in groups, such as how much attention people get or how much they talk, can differ by gender (Chatman and O'Reilly, 2004; Ritter and Yoder, 2004), with men often garnering more attention than women (Gerpott *et al.*, 2018).

We tested two questions: one, whether physiological linkage from senders to receivers is associated with the receiver's role (see Panel A, Figure 1) to test whether high-status women's success at persuading the group to make a decision in their favor would be associated with other group members predicting their physiological responses. We explored whether this effect would be moderated by the gender of the sender (in other words, are the physiological responses of successful high-status women predicted by the physiological responses of their group members differently depending on those group members' gender?).

Two, we examined whether physiological linkage from senders to receivers is associated with the sender's role (see Panel B, Figure 1) to test whether high-status women's success at persuading the group to make a decision in their favor would be associated with them predicting other group members' physiological responses. We again explored whether this effect might vary by receiver gender (in other words, are the physiological responses of successful high-status women predicting the physiological responses of their group members differently depending on those group members' gender?).

Method

Additional methodological details and results are provided in the Supplemental Material (SM); study materials, data, and syntax are available at https://osf.io/f75ej/.

Participants

Participants were 119 students in 31 groups (26 four-person groups and 5 three-person groups)[1] from 55 countries (46 from the continent of Asia, 38 from Europe, 13 from North America, 11 from Africa, 6 from Oceania, and 5 from South America) and recruited from NYU Abu Dhabi (see Table S1 in SM; $M_{age} = 20.52$ years, $s.d._{age} = 1.48$ years; 57.1% female, 42.9% male). The average GII was 0.79 (s.d. = 0.13) and ranged from 0.47 to 0.95 (see Table S1 in SM).

Participants were pre-screened to ensure that they had a body mass index lower than 30, were not taking cardiac medications, were not pregnant, and did not have a pacemaker or a doctor's diagnosis of a heart arrhythmia or hypertension (Blascovich *et al.* 2011). This study received research ethics committee approval, and participants gave informed consent. All participants received 50 AED for participation; some also received a potential bonus of 20 AED (described below).

Procedure

Baseline

Participants arrived at the laboratory in groups of three or four people (see Figure 2). Each participant was directed to a cubicle,

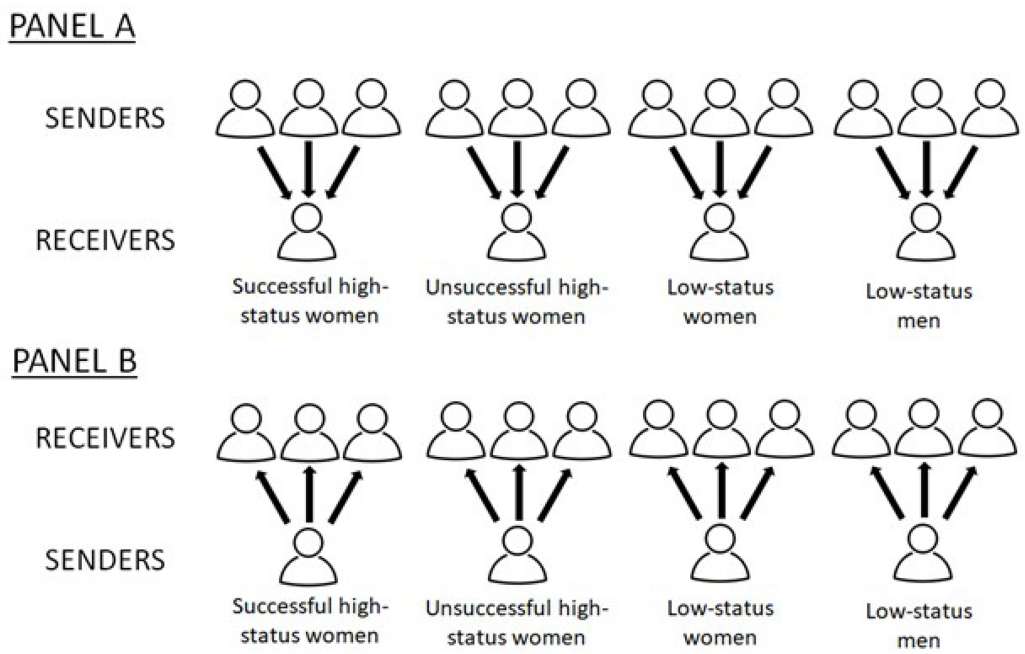

Fig. 1. Models of physiological linkage. Senders' physiological responses predict the physiological responses of receivers at a following time interval. The receivers are said to be 'physiologically linked' to the sender. Panel A: People's role affects the extent to which they are receivers of physiological linkage (i.e. other people's physiological responses predict their physiological responses). Panel B: People's role affects the extent to which they are senders of physiological linkage (i.e. how much their physiological responses affect the responses of other group members).

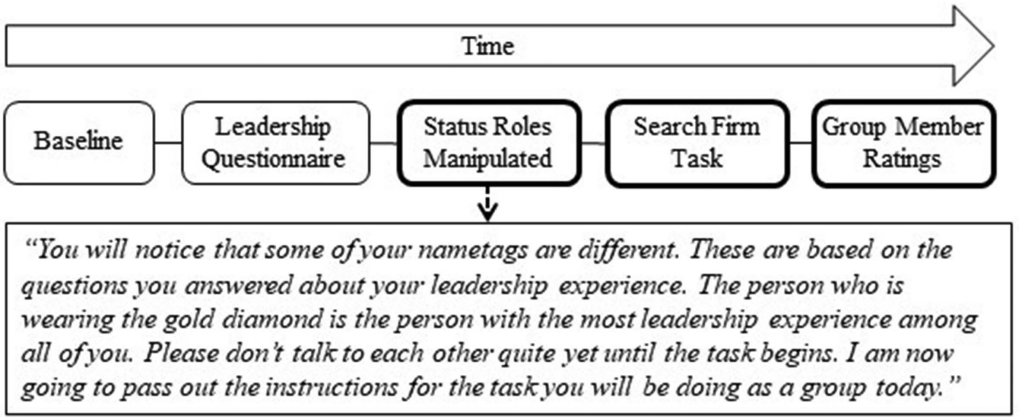

Fig. 2. Overview of the procedure. Bold outlines indicate that group members were sitting at the same table; at all other times, group members were in separate cubicles in the same room.

where an experimenter explained how to attach electrocardiography (ECG) sensors to their torsos. We recorded a five-minute physiological baseline while participants watched a relaxing video about nature.

Status manipulation

After baseline, participants completed a leadership questionnaire in which they rated themselves on leadership traits and listed their past leadership positions and current GPA. Participants were then told that we would use their responses to provide them with more information about their groupmates prior to working with them, after which an experimenter ostensibly scored the questionnaires. Next, experimenters helped move participants from their individual cubicles to sit around a table together. Each participant was given a randomly assigned nametag with a letter and symbol. We told participants that the person with the gold diamond and the letter A had the most leadership experience (high-status) based on the questionnaires. The other two or three group members (referred to as 'low-status' group members in this paper) were provided with nametags with the letter B, C or D and the symbol of a blue square; they were not told anything about their levels of leadership experience.

Group decision-making task

Experimenters then passed out instructions to be read privately by each participant. These explained that the group's task was to select the best of five executive search firms—with a description of each firm—to assist in hiring a senior vice president of business development. High-status participants were also privately told to convince the group to hire one search firm that was specified on the instructions and that they would receive a 20-AED reward if they were successful at convincing the rest of the group to select their search firm without revealing this goal. The specific search firms were randomized across sessions. Other participants in the group did not receive special instructions to argue for a particular firm.

Participants were told they would have 10 minutes to reach a decision and that they could select a firm with a unanimous vote, a majority vote (three people agreed in a group of four or two people agreed in a group of three), or they could make no decision. To incentivize participants to engage in the task, we also told participants that videos of them during the task would be judged by laboratory research assistants and that the person who was judged to be the most persuasive would be given an extra 20 AED. During the discussion, participants discussed the firms in whatever manner they wanted (with the exception that the high-status members could not reveal that we had instructed them to argue for a particular firm). IBIs were obtained continuously for the entire task. Experimenters listened to ensure that people in the high-status role did not disclose their specific search firm assignment; none did. Participants completed a questionnaire and were debriefed.

Measures

Manipulation checks

Understanding/recall of the manipulation. After the status manipulation, participants indicated which group member had the most leadership experience.

IBI reactivity. We used three snap electrodes to record ECG responses with an integrated system (Biopac MP150 and ECG100C, Biopac Systems, Goleta, CA). We processed the data in 30-second intervals using Mindware's heart rate variability software (HRV 3.0.25, Mindware Technologies, Gahanna, OH), which identified the R-point of each heartbeat on the ECG waveform. We chose intervals of 30 seconds because they are long enough to capture changes in IBI due to psychological experiences and because, in our experience, they tend to capture linkage that occurs during the natural back-and-forths and exchanges that occur in conversations (Thorson *et al.*, 2019b; Waters *et al.*, 2020).

The first author inspected the data for any R-points that had been incorrectly identified by the software and appropriately identified these. The first author also inspected the data for any segments for which R-points could not be identified. If these segments were shorter than approximately eight seconds long (25% of a 30-second interval) and were at the beginning or end of the 30-second interval, these segments were not included in the average IBI for that interval. If these segments were longer than 8 seconds or in the middle of a 30-second interval, those intervals were marked as missing, given that we could not obtain accurate mean IBIs for them. We computed reactivity scores by subtracting the mean IBI from the last 30-second segment of baseline

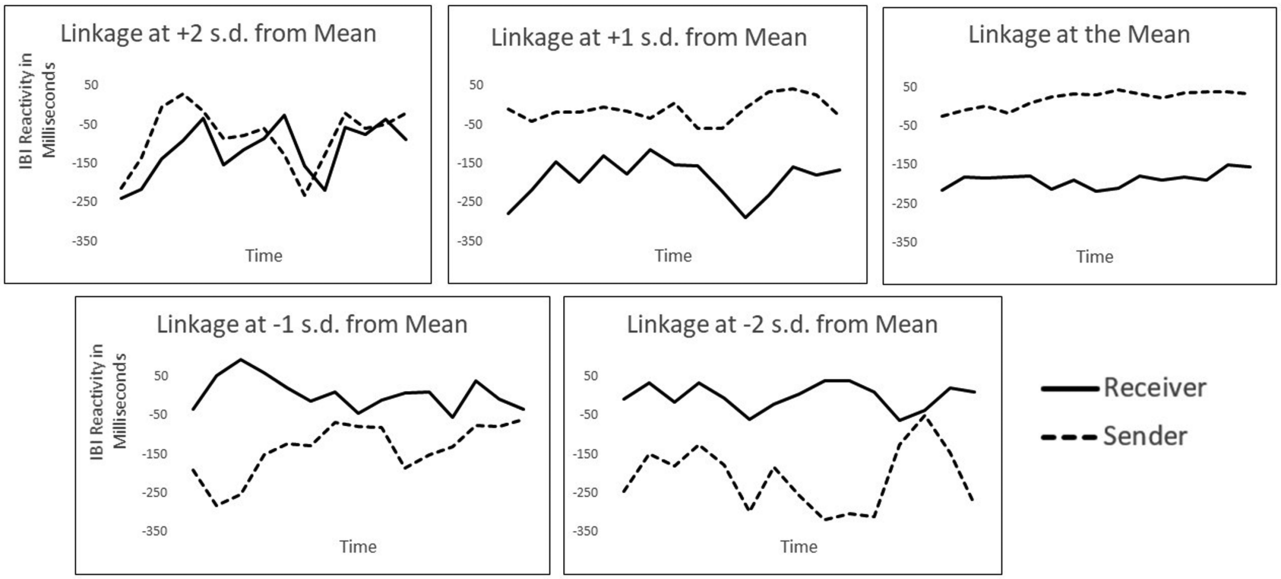

Fig. 3. IBI reactivity scores for five receiver and sender dyadic combinations over time. These receiver and sender IBI reactivity trajectories result in linkage estimates for the receiver at different distances from the mean linkage estimate. SD, standard deviation.

from the mean IBI of each 30-second segment of the group task. Each participant could have a maximum of 20 reactivity scores across the 10 minutes of the group task.

Perceptions of persuasiveness

After the group task, we asked participants 'How persuasive was Group Member [letter] during the group task?' on a scale of 1 (*not at all persuasive*) to 7 (*extremely persuasive*).

Physiological linkage

We calculated physiological linkage scores for all of the dyadic combinations in one group so that we could examine how much each participant's IBI reactivity score predicted each of their partners' reactivity scores (for sender linkage) and was predicted by each of their partners' reactivity scores (for receiver linkage). To calculate linkage scores from reactivity scores, we estimated a regression model for each person in each dyad (see equation (1) and Table 1), predicting the receiver's (person *i*'s) reactivity score at time interval T from the partner's (the sender's) reactivity score at time interval T-1 and the receiver's own reactivity score at time interval T-1. We adjusted for stability—receivers' own prior physiology—when calculating linkage, based on the approach outlined in Thorson *et al.* (2018, 2019). We marked as missing linkage estimates that were more extreme than three s.d. from the mean linkage estimate (1.5% of possible linkage estimates). The average linkage estimate was 0.02 (s.d. = 0.32, *min* = − 1.01, *max* = 0.99; see Figure 3 for a depiction of linkage at high and low values).

$$Y_{ijt} = b_{0ij} + b_{1ij} * S_{ij(t-1)} + b_{2ij} * R_{ij(t-1)} + e_{ijt} \quad (1)$$

In analyses reported below, we treated linkage scores as an outcome using Generalized Estimating Equations (GEE), a marginalized modeling strategy designed to adjust for non-independence of scores nested within group (Zeger and Liang, 1986), specifying an exchangeable correlation matrix.

Results

Manipulation checks

Understanding/recall of the manipulation. Almost all (97.5%; $n = 116$) participants correctly said that group member A had the most leadership experience.

IBI reactivity. We expected to find that participants in the high-status condition would exhibit greater IBI reactivity than participants in the low-status condition given their more demanding task. We anticipated linear decreases in reactivity over time for everyone, given expected habituation to the task, so we included a linear effect of time in the models and a Condition (two levels: high-status and low-status) × Time interaction term (see SM for more details). Because IBI is the amount of time in milliseconds between heartbeats, more negative reactivity values indicate faster heartbeats.

We found a main effect of time, $F(1, 102.03) = 25.86$, $P < 0.001$, such that participants' reactivity declined over the study (see Figure 3), and a main effect of condition, $F(1, 93.35) = 5.49$, $P = 0.021$. Consistent with our expectations, high-status participants showed stronger reactivity ($M = -146.03$, s.d. = 93.37) than low-status participants ($M = -103.27$, s.d. = 108.07), and this did not vary over time, $F(1, 102.04) = 0.44$, $P = 0.51$.

Group decisions

A total of 28 groups (90.3%) came to a decision regarding which search firm to choose. Twenty-two of the decisions (78.6%) were unanimous, and six (21.4%) were reached by a majority vote. In every group, one firm was advocated for by a high-status participant, leaving four firms left over. Seventeen groups (60.7%) selected the firm that was advocated for by the high-status person, and 11 groups (39.2%) selected a different firm. At chance, there is a 20% likelihood that the firm advocated for by the high-status person would be selected, and an 80% chance that another firm would be selected; we used these as the expected

Table 1. Terms in equation (1)

Description	Which dyadic partner provides the data?
IBI reactivity for person *i* in dyad *j* at time interval *t*	Person *i* in dyad *j* (the receiver in this equation)
Intercept for person *i* in dyad *j*	
Linkage estimate for person *i* in dyad *j* (as the receiver) calculated as the slope for person *i* in dyad *j* for the sender's IBI reactivity	
Sender's IBI reactivity for person *i* in dyad *j* at time interval (*t*—1)	Person *i*'s partner in dyad *j* (the sender in this equation)
Stability estimate for person *i* in dyad *j* calculated as the slope for person *i* in dyad *j* for receiver's IBI reactivity	
Receiver's IBI reactivity for person *i* in dyad *j* at time interval (*t*—1)	Person *i* in dyad *j* (the receiver in this equation)
Residual error for person *i* in dyad *j* at time interval *t*	

This is the equation for person *i* in dyad *j* that creates the linkage score for person *i* as the receiver of linkage. The score for person *i* as the sender of linkage is created with the analogous equation for person *i*'s partner in dyad *j*.

frequencies and conducted a chi square test of independence. Observed frequencies were different than expected by chance, $\chi^2(2) = 29.01$, $P < 0.001$, meaning that groups were more likely than chance to select the firm advocated for by the high-status person.

Perceptions of persuasiveness

We examined how persuasive people thought each group member was during the task, treating role as the predictor (4 levels: high-status successful women, high-status unsuccessful women, low-status women, and low-status men) and using multilevel modeling to adjust for nonindependence among group members. We found a main effect of role, $F(3, 113.01) = 2.81$, $P = 0.043$: successful high-status women were seen as more persuasive ($M = 4.83$, s.d. $= 1.08$) than unsuccessful high-status women ($M = 3.90$, s.d. $= 1.40$), $t(114.51) = -2.49$, $P = 0.014$, low-status women ($M = 4.06$, s.d. $= 1.54$), $t(113.30) = -2.56$, $P = 0.012$, and low-status men ($M = 4.25$, s.d. $= 1.48$), $t(112.69) = -2.00$, $P = 0.047$. None of the other groups differed from one another (*p*s > 0.21).

Physiological linkage

Do successful high-status women show linkage to others?

We examined whether there was an effect of role on the extent to which people were 'receivers' in models of physiological linkage (see Panel A, Figure 1). To do this, we predicted people's linkage scores (the slope b_{1ij} in equation (1)) from their role. We found a marginal main effect of role, $\chi^2(3) = 6.54$, $P = 0.088$. Follow-up analyses indicated that the physiological responses of successful high-status women were significantly predicted by the responses of their fellow group members, $\chi^2(1) = 4.68$, $P = 0.031$ (see Table 2 and Figure 5). In contrast, the physiological responses of unsuccessful high-status women, low-status women, and low-status men were not significantly predicted by the responses of their fellow group members: unsuccessful high-status women: $\chi^2(1) = 1.60$, $P = 0.21$; low-status women: $\chi^2(1) = 1.43$, $P = 0.23$; low-status men: $\chi^2(1) < 0.001$, $P = 0.99$).

The difference in linkage between successful high-status women and unsuccessful high status-women was significant, $P = 0.022$, and the difference in linkage between successful high-status women and low-status men was marginally significant, $P = 0.07$. Successful high-status women did not show significantly more linkage to group members than did low-status women, $P = 0.46$. Low-status women showed marginally more linkage to their team members than unsuccessful, high-status women, $P = 0.097$. No other significant differences were found between roles, *p*s > 0.26.

Table 2. Physiological linkage as a function of receiver and sender role

	Linkage as receivers	Linkage as senders
Successful high-status women	0.09 (0.23)	−0.05 (0.29)
Unsuccessful high-status women	−0.06 (0.27)	0.02 (0.33)
Low-status women	0.03 (0.33)	0.05 (0.30)
Low-status men	−0.001 (0.33)	0.03 (0.34)

Means are unstandardized regression coefficients of linkage scores (the slope coefficient b_{1ij} in equation (1). s.d. are in parentheses.
[1]We examined whether group size or group gender composition influenced any of our primary results and did not find evidence that they did (see SM).

Do successful high-status women show linkage to others as a function of their gender. We next examined whether senders' gender interacted with receiver role to predict physiological linkage from senders to receivers. We included the main effect of receiver role, the main effect of sender gender (male *vs* female), and the two-way interaction term between receiver role and sender gender. A significant main effect of receiver role was found, $\chi^2(3) = 8.09$, $P = 0.044$. The main effect of sender gender was not significant, $\chi^2(1) = 0.08$, $P = 0.78$. There was a significant two-way receiver role by sender gender interaction, $\chi^2(3) = 12.25$, $P = 0.007$. We next examine the main effect of sender gender separately for each role.

Successful high-status women. Overall, successful high-status women showed significant linkage to other group members, $\chi^2(1) = 7.67$, $P = 0.006$, but this varied as a function of their group members' gender (sender gender), $\chi^2(1) = 10.11$, $P = 0.001$. The physiological responses of successful high-status women were significantly predicted by the physiological responses of female group members' responses, $\chi^2(1) = 17.66$, $P < 0.001$, ($M = 0.20$, s.d. $= 0.21$) but not by male group members' responses, $\chi^2(1) = 0.09$, $P = 0.77$, ($M = 0.004$, s.d. $= 0.21$).

Unsuccessful high-status women. Unsuccessful high-status women did not show significant linkage to their group members, $\chi^2(1) = 1.75$, $P = 0.19$, and this did not vary as a function of their group members' gender, $\chi^2(1) = 0.90$, $P = 0.34$.

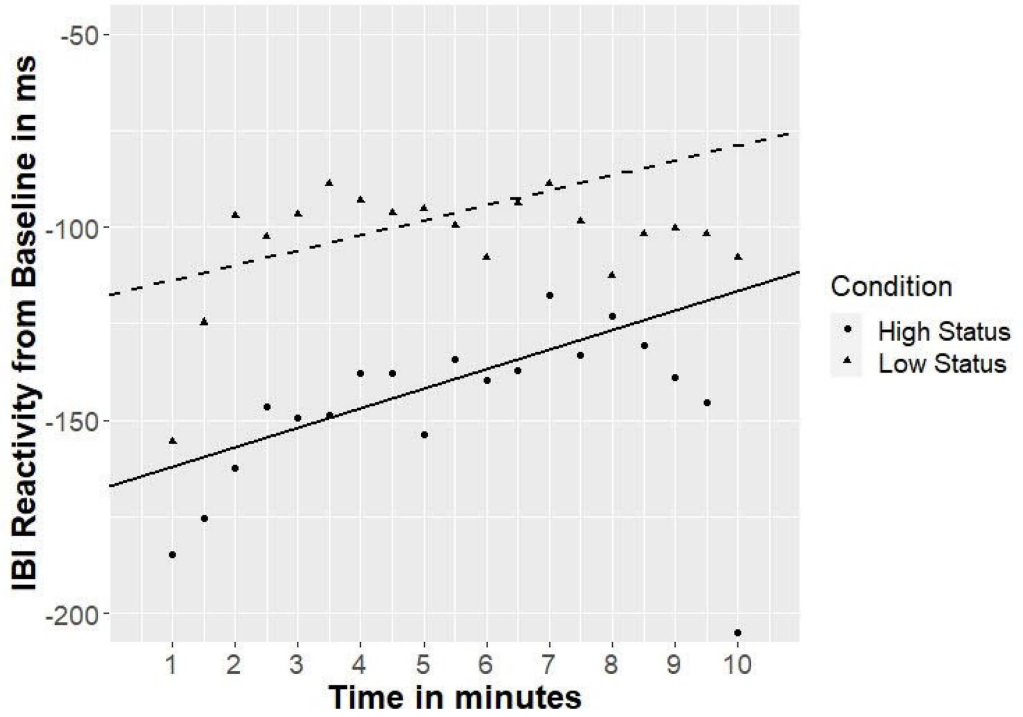

Fig. 4. IBI reactivity over time. Lines indicate predicted values; diamonds and circles represent average values for people in the low- and high-status conditions, respectively.

Low-status women. Low-status women did not show significant linkage to their group members, $\chi^2(1) = 1.10$, $P = 0.30$, and this did not vary as a function of their group members' gender, $\chi^2(1) = 0.01$, $P = 0.91$.

Low-status men. Low-status men did not show significant linkage to their group members, $\chi^2(1) = 0.08$, $P = 0.78$, and this did not vary as a function of their group members' gender, $\chi^2(1) = 1.62$, $P = 0.20$.

In summary, the physiological responses of only one group of people were predicted by the responses of their fellow group members: successful high-status women. Furthermore, their responses were only predicted by the responses of other women in their group but not of other men.

Do people show linkage to successful high-status women?

We examined whether there was an effect of role on the extent to which people were 'senders' in models of physiological linkage (see Panel B, Figure 1 and the slope b_{1ij} in equation (1); see Table 2 for results). There was no main effect of role, $\chi^2(3) = 3.61$, $P = 0.31$. We further examined whether this effect was moderated by receiver gender and found that it was not, $\chi^2(3) = 1.77$, $P = 0.62$.

Discussion

We investigated the relationship between physiological linkage and successful persuasion in groups in which one female group member was assigned a high-status role and instructed to argue for a specific decision. We found that only successful high-status women showed physiological linkage to other group members during the decision-making task. In other words, successful high-status women's physiology was influenced in a time-lagged fashion by the other group members' physiology, placing them in the position of 'receivers' of physiological linkage. This effect was moderated by the gender of the sender, such that successful high-status women showed significant linkage to other women in the group but did not show significant linkage to the men in the group. These results were also supported by the finding that successful high-status women were seen as more persuasive compared to all other group member categories.

We found that the physiological responses of persuasive group members were predicted by the responses of their fellow group members and not the other way around. Several studies suggest that physiological linkage can occur when people are attuned to others' psychological states (Marci and Orr, 2006; West *et al.*, 2017; Thorson *et al.*, 2019b), and we have theorized that receivers become 'linked' to senders when they are attentive to cues that the sender expresses and which are tied to the sender's physiological response. Thus, our findings align with research showing that people may be more likely to successfully persuade others if they pay attention to them, understand their preferences, and adjust their own behavior accordingly (Atwater and Yammarino, 1997; Sosik *et al.*, 2002).

Our research adds to a growing body of work examining how interpersonal processes—specifically, group persuasion—are associated with physiological linkage and synchrony, more broadly. By examining linkage within groups at a dyadic level—measuring how much each group member is 'linked to' each other group member (in contrast to studying synchrony with a single group score; e.g. Quer *et al.*, 2016), our work shows that there is variability in *who* shows linkage *to whom*; only some members of the group are physiologically linked to others

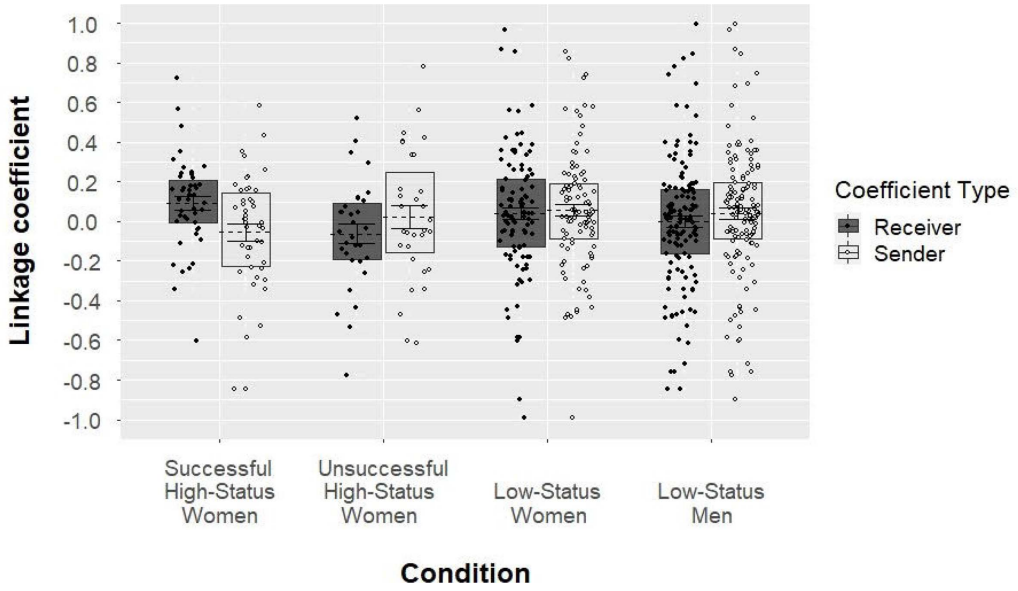

Fig. 5. Boxplot of receiver and sender linkage coefficients by condition. Dashed lines are means of unstandardized regression coefficients. Error bars are standard errors.

(successful persuaders) and they are only linked to specific others (women). Thus, this work moves beyond linkage as a 'group-level' process, showing that the unique dyadic combinations of linkage within a group are tied to group processes.

Our work extends research regarding the role of women as leaders in mixed-gender, heterogeneous teams. To date, many studies that examine leadership in real groups focus on nationally homogeneous teams (for an exception see Earley and Mosakowski, 2000). We focus on nationally heterogeneous teams where members come from different countries that vary in the degree to which women are represented in leadership positions. This point of departure is an important one, given the increase in cross-national interactions in the global workforce. Moreover, we extend work that has primarily focused on male leaders to test whether women who are high-status are able to effectively persuade team members. Despite strong variability in the exposure that participants had to female leaders as a function of their home countries, women in these groups were still able to successfully persuade their groups overall, and those who were successful in doing this were still seen as the most persuasive.

Limitations and future directions

The present research could be extended in a number of ways. In particular, it would be interesting to know whether male leaders in mixed-gender teams show physiological linkage to other group members at all and whether this is associated with their success at persuading other team members. If physiological linkage occurs because people are paying attention to each other, male leaders may need to pay less attention to other group members in order to persuade them. They may simply garner more attention as a result of their combined leadership position and gender, which may be enough to persuade people without paying attention to them and adjusting their behavior accordingly. These gender differences in attention to others might then be reflected in physiological linkage differences as well. Another possibility is that male leaders show linkage to other group members, but it may not depend on the gender of other group members if gender is a less salient cue for men than for women. Understanding whether male leaders experience physiological linkage in similar ways as women would not only help us understand how much the effects found here generalize beyond women but could also yield insight into the processes through which linkage in groups occurs.

Our finding that successful high-status women showed physiological linkage to the low-status women in the group aligns with research showing that the presence of other women can positively influence women's behaviors in group decision-making tasks (Johnson and Schulman, 1989) and that being exposed to female leaders can improve women's leadership behaviors (Latu *et al.*, 2013; Asgari *et al.*, 2012). We looked for evidence of certain behaviors that might be associated with this linkage pattern, such as talk time, number of interruptions made, and number of arguments made for and against specific choices, but we did not find any significant effects of role on these behaviors (see SM). Future research could further investigate the relationship between physiological linkage and persuasion in group contexts by manipulating the degree to which high-status women pay attention to other women in the group, as well as by exploring additional behaviors associated with successful persuasion and linkage.

Lastly, future research on mixed-gender groups might examine whether female and/or male leaders are better able to persuade groups with more members of their own gender, as well as how the gender composition of the group affects people's ratings of the group leaders. In groups with fewer women, are female leaders even more likely to pay attention to other women in the group, potentially resulting in stronger physiological linkage to them? Especially in nationally heterogeneous teams where gender might be one clear cue that unites or divides people across a backdrop of other differences, how leaders pay attention to and rely on other group members as a function of their own gender and group's gender composition is important to know.

Conclusion

In nationally heterogeneous, mixed-gender teams, we found that women with high-status were, on average, successful at persuading their group members and were also seen as more persuasive than other group members. In addition, their physiological responses were predicted by those of other women in the group. Our findings suggest that, in the context of group decision-making, one possible predictor of successful persuasion is how skilled individuals are at attending to their group members and adjusting their own behavior accordingly, which may lead to physiological linkage to the interaction partner.

Supplementary data

Supplementary data are available at *SCAN* online.

Conflict of interest

None declared.

References

Anderson, C., Berdahl, J.L. (2002). The experience of power: examining the effects of power on approach and inhibition tendencies. *Journal of Personality and Social Psychology*, *83*(6), 1362.

Arnett, J.J. (2008). The neglected 95%: why American psychology needs to become less American. *American Psychologist*, *63*(7), 602.

Asgari, S., Dasgupta, N., Stout, J.G. (2012). When do counterstereotypic ingroup members inspire versus deflate? The effect of successful professional women on young women's leadership self-concept. *Personality & Social Psychology Bulletin*, *38*(3), 370–83.

Atwater, L.E., Yammarino, F.J. (1997). Self-other rating agreement: a review and model. In: Ferris, G.R. editor, *Research in Personnel and Human Resources Management*, Vol. 15, 121–74. Elsevier Science/JAI Press.

Berger, J., Cohen, B.P., Zelditch, J.M. (1972). Status characteristics and social interaction. *American Sociological Review*, 241–55.

Blascovich, J., Vanman, E., Mendes, W., Dickerson, S. (2011). Social psychophysiology for social and personality psychology. *Sage, London.*,

Chatman, J.A., O'Reilly, C.A. (2004). Asymmetric reactions to work group sex diversity among men and women. *Academy of Management Journal*, *47*(2), 193–208.

Devine, D.J., Clayton, L.D., Dunford, B.B., Seying, R., Pryce, J. (2001). Jury decision making: 45 years of empirical research on deliberating groups. *Psychology, Public Policy, and Law*, *7*(3), 622–727.

Earley, C.P., Mosakowski, E. (2000). Creating hybrid team cultures: an empirical test of transnational team functioning. *Academy of Management Journal*, *43*(1), 26–49.

Fiske, S.T. (2010). Interpersonal stratification: status, power, and subordination. In: Fiske, S.T., Gilbert, D.T., Lindzey, G., editors. *Handbook of Social Psychology*, 941–82. Hoboken, NJ: Wiley.

Galinsky, A.D., Gruenfeld, D.H., Magee, J.C. (2003). From power to action. *Journal of Personality and Social Psychology*, *85*(3), 453.

Gerpott, F.H., Lehmann-Willenbrock, N., Silvis, J.D., Van Vugt, M. (2018). In the eye of the beholder? An eye-tracking experiment on emergent leadership in team interactions. *The Leadership Quarterly*, *29*(4), 523–32.

Haataja, E., Malmberg, J., Järvelä, S. (2018). Monitoring in collaborative learning: co-occurrence of observed behavior and physiological synchrony explored. *Computers in Human Behavior*, *87*, 337–47.

Henrich, J., Heine, S.J., Norenzayan, A. (2010). Most people are not WEIRD. *Nature*, *466*(7302), 29.

Johnson, R.A., Schulman, G.I. (1989). Gender-role composition and role entrapment in decision-making groups. *Gender & Society*, *3*(3), 355–72.

Latu, I.M., Mast, M.S., Lammers, J., Bombari, D. (2013). Successful female leaders empower women's behavior in leadership tasks. *Journal of Experimental Social Psychology*, *49*(3), 444–48.

Marci, C.D., Orr, S.P. (2006). The effect of emotional distance on psychophysiologic concordance and perceived empathy between patient and interviewer. *Applied Psychophysiology and Biofeedback*, *31*(2), 115–28.

Mønster, D., Håkonsson, D.D., Eskildsen, J.K., Wallot, S. (2016). Physiological evidence of interpersonal dynamics in a cooperative production task. *Physiology & Behavior*, *156*, 24–34.

O'Brien, D.Z., Rickne, J. (2016). Gender quotas and women's political leadership. *American Political Science Review*, *110*(1), 112–26.

Obrist, P.A. (1981). *Cardiovascular Psychophysiology: A Perspective*. New York: Plenum Press.

Paluck, E.L., Shepherd, H., Aronow, P.M. (2016). Changing climates of conflict: a social network experiment in 56 schools. *Proceedings of the National Academy of Sciences*, *113*(3), 566–71.

Palumbo, R.V., Marraccini, M.E., Weyandt, L.L. et al (2017). Interpersonal autonomic physiology: a systematic review of the literature. *Personality and Social Psychology Review*, *21*(2), 99–141.

Quer, G., Daftari, J., Rao, R.R. (2016). Heart rate wavelet coherence analysis to investigate group entrainment. *Pervasive and Mobile Computing*, *28*, 21–34.

Ritter, B.A., Yoder, J.D. (2004). Gender differences in leader emergence persist even for dominant women: an updated confirmation of role congruity theory. *Psychology of Women Quarterly*, *28*(3), 187–93.

Sosik, J.J., Potosky, D., Jung, D.I. (2002). Adaptive self-regulation: meeting others' expectations of leadership and performance. *The Journal of Social Psychology*, *142*(2), 211–32.

Thorson, K.R., Dumitru, O.D., Mendes, W.B., West, T.V. (2019). Influencing the physiology and decisions of groups: physiological linkage during group decision-making. *Group Processes and Intergroup Relations*, *00*(0), 1–15.

Thorson, K.R., Forbes, C.E., Magerman, A.B., West, T. (2019). Under threat but engaged: stereotype threat leads women to engage with female but not male partners in math. *Contemporary Educational Psychology*, *58*, 243–59.

Thorson, K.R., West, T.V., Mendes, W.B. (2018). Measuring physiological influence in dyads: a guide to designing, implementing, and analyzing dyadic physiological studies. *Psychological Methods*, *23*(4), 595–616.

Timmons, A.C., Margolin, G., Saxbe, D.E. (2015). Physiological linkage in couples and its implications for individual and interpersonal functioning: a literature review. *Journal of Family Psychology*, *29*(5), 720.

Watson, W.E., Kumar, K. (1992). Differences in decision making regarding risk taking: a comparison of culturally diverse and culturally homogeneous task groups. *International Journal of Intercultural Relations*, *16*(1), 53–65.

Waters, S.F., Karnilowicz, H.R., West, T.V., Mendes, W.B. (2020). Keep it to yourself? Parent emotion suppression influences physiological linkage and interaction behavior. *Journal of Family Psychology*.

West, T.V., Koslov, K., Page-Gould, E., Major, B., Mendes, W.B. (2017). Contagious anxiety: anxious European Americans can transmit their physiological reactivity to African Americans. *Psychological Science*, *28*(12), 1796–806.

Wright, R.A., Kirby, L.D. (2001). Effort determination of cardiovascular response: an integrative analysis with applications in social psychology. *Advances in Experimental Social Psychology*, *33*, 255–307.

Zakaria, N., Amelinckx, A., Wilemon, D. (2004). Working together apart? Building a knowledge-sharing culture for global virtual teams. *Creativity and Innovation Management*, *13*(1), 15–29.

Zeger, S.L., Liang, K.Y. (1986). Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*, 121–30.