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Short Communication

In the eye of the beholder? An eye-tracking experiment on emergent leadership in team interactions

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A R T I C L E I N F O

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A B S T R A C T

Integrating evolutionary signaling theory with a social attention approach, we argue that individuals possess a fast, automated mechanism for detecting leadership signals in fellow humans that is reflected in higher visual attention toward emergent leaders compared to non-leaders. To test this notion, we first videotaped meetings of project teams and collected leadership ratings for the team members from three rating sources. Second, we provided 18 naïve observers with 42 brief, muted video clips of the team meetings and analyzed their eye gazing patterns. Observers gazed at emergent leaders more often, and for an average longer duration, than at non-leaders. Gender effects occurred such that male emergent leaders received a higher number of fixations than female emergent leaders. Non-verbal behavior analysis indicated that emergent leaders showed a higher amount of active gestures and less passive facial expressions than non-leaders. We discuss theoretical and methodological directions for emergent leadership research in teams.

"You can observe a lot by just watching." (Yogi Berra)

In all kinds of groups, human and nonhuman, leader and follower hierarchies are formed naturally because of their functionality for solving social coordination challenges (Bass, 1954; King, Johnson, & Van Vugt, 2009; Neubert & Taggar, 2004; Van Vugt, 2006; Winsborough, Kaiser, & Hogan, 2009). Hence, in initially leaderless groups, some individuals typically emerge as leaders; these individuals are perceived by others as taking over leadership responsibilities (Hogan, Curphy, & Hogan, 1994). Whereas research on emergent leadership has been heavily influenced by the "great person" perspective that investigates emergent leaders' traits and characteristics (Wellman, 2017), only a few studies focused on the role of those who pay attention to leadership signals. This is surprising, given that the competence to correctly infer who is the informal leader, or who it is worth following, is essential to become part of an effective group with higher survival chances than groups characterized by ineffective leadership (Spisak, Homan, Grabo, & Van Vugt, 2012).

An evolutionary signaling perspective on leadership suggests that individuals convey certain leadership signals which were markers of good leadership in ancestral environments and that observers should be able to immediately grasp these signals (Grabo, Spisak, & Van Vugt, 2017). Relatedly, an embodiment perspective on signaling assumes that these embodied signals flow directly from the emergent leaders or the immediate environment and do not necessarily involve verbal instructions (Reh, Van Quaquebeke, & Giessner, 2017). Indeed, research has shown that people ascribe leadership potential to others based on a range of static cues[1] such as physical height (Judge & Cable, 2004; Stulp, Abraham, Verhulst, & Pollet, 2013) or facial characteristics (Re et al., 2013; Rule & Ambady, 2008). Experimental evidence suggests that these signals may have evolved as accurate indicators of competence and power, which in turn should promote group effectiveness (Bellew & Todorov, 2007; Castelnovo, Popper, & Koren, 2017; Todorov, Mandisodza, Goren, & Hall, 2005).

However, in social situations static signals of competence and power may not directly translate to the ascription of leadership because leadership emergence is an outcome of dynamic interactions (Uhl-Bien, 2006; Uhl-Bien, Marion, & McKelvey, 2007). This means that individuals send various signals simultaneously, such as physical characteristics, nonverbal body language, or verbal cues, and observers are confronted with the challenge of inferring leadership from the variety of different competence signals. Initial evidence indicates that people can extract leadership cues (i.e., perceived charismatic behavior) from watching muted speech clips that show a person sending various

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[1] Not every cue is a signal; only when a cue has been selected by evolution because it increases the survival chances of senders (i.e., emergent leaders) and receivers (i.e., observers), it qualifies as a signal (Grabo et al., 2017; Henrich, 2009).

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leadership cues simultaneously, and that these perceptions predict leader prototypicality ratings (Tskhay, Zhu, & Rule, 2017). Yet, whereas such perceptual measures of leadership may capture a rather complex mental representation of leadership signals, we do not know whether leadership signals also trigger more automatic, rapid attention processes at a behavioral level. Given that early-stage cognition processes provide the building blocks of more complex, higher-order cognitive processes (Maner, DeWall, & Gailliot, 2008; Maner, Gailliot, & DeWall, 2007), an investigation of basic social attention mechanisms is important for a more comprehensive understanding of emergent leadership.

Functional social attention theory (Emery, 2000; Klein, Shepherd, & Platt, 2009) proposes that our sense systems such as social gaze have evolved to help individuals survive in social settings by immediately focusing on cues of relevance. Hence, a predisposed attention bias toward emergent leaders' signals in group interactions should be reflected in sensorial activities such as people's eye-gazing patterns. Integrating the social attention perspective with the assumptions of signaling theory, we thus assume that people's evolved "sense for seeing leadership" should manifest in an automatic tendency to gaze more often and for a longer duration at individuals who send out embodied leadership cues (and thus emerge as leaders) compared to non-leaders.

Our research offers several contributions to the literature. First, we add to theorizing about the origins of leadership as an ancient social coordination mechanism, predating the evolution of language in humans. Indeed, simple forms of leadership occur in a wide variety of species that signal leadership through nonverbal behaviors (Van Vugt, Hogan, & Kaiser, 2008). For example, the swimming patterns of fish, the flying patterns of migrating birds, and the movement patterns of non-human primates resemble leader-follower structures and reflect the two key ingredients of emergent leadership: someone is signaling the willingness to move the group (i.e., signaling theory) and someone is paying attention to these signals (i.e., functional social attention theory). Based on this phylogenetic evidence, we argue that individuals possess a fast, highly automated mechanism for detecting leadership potential in fellow humans.

Second, we use a triangulated approach involving three different raters to determine emergent leaders and then investigate naïve observers' actual behavior (namely their visual attention) when watching dynamic group situations in a natural project setting to shed light on the social attention bias toward emergent leaders. As such, we extend previous work that has relied on (1) observers' *perceptions* of emergent leadership from thin slices of behavior (e.g., Tskhay et al., 2017; Tskhay, Xu, & Rule, 2014), (2) *single* nonverbal cues of emergent leaders (e.g., physical height, Judge & Cable, 2004; Stulp et al., 2013), (3) *static* stimulus material (e.g., pictures, Re et al., 2013; Rule & Ambady, 2008) and (4) controlled *laboratory* settings (e.g., Cherulnik, Turns, & Wilderman, 1990; Re et al., 2013).

Third, we provide initial insights into the mechanisms through which emergent leaders may attract the social attention of naïve observers by exploring emergent leaders' and non-leaders' nonverbal behaviors from video clips. To do so, we adapt an established coding scheme (Bartel & Saavedra, 2000) that differentiates between active/approaching and passive/nervous postural cues and facial expressions to investigate nonverbal behavioral differences between emergent leaders and non-leaders. This design addresses some of the challenges inherent in survey-based research on emergent leadership such as halo effects that reflect an overall positive attitude toward a leader instead of actual behavior (Baumeister, Vohs, & Funder, 2007) or endogeneity problems (Antonakis, Bendahan, Jacquart, & Lalive, 2010).

Theoretical background

Attention to leadership cues

Actors in the "market of leader emergence" engage in purposeful signaling strategies—"things one does that are visible and that are in part designed to communicate" (Spence, 2002, p. 434)—to focus others' cognitive resources on the most informative cues pertaining to leadership (Antonakis, Bastardoz, Jacquart, & Shamir, 2016). Given that the social environment in which individuals interact is characterized by insufficient information, emergent leaders may use a range of verbal and nonverbal signals—and often make extensive use of both (Antonakis et al., 2016; Reh et al., 2017)—to indicate their ability for successfully coordinating groups in complex environments. Yet, whereas much research has investigated how people draw inferences about leadership from verbal tactics (e.g., Pavitt, Whitchurch, Siple, & Petersen, 1997; Tskhay et al., 2017), both evolutionary signaling theory and the embodiment signaling perspective of leadership provide conceptual reasons to assume that individuals also make intensive use of nonverbal social signals to draw inferences about whom to follow in groups.

First, from an evolutionary signaling perspective, selection favored individuals who possessed the ability to automatically and accurately recognize and attend to signals of leadership. Being able to draw immediate inferences about the leader in a group was helpful for solving urgent coordination challenges such as a resource crisis or an intragroup dispute (Boehm, 1999). Moreover, individuals with a comprehensive ability to evaluate the relative fitness of themselves and other group members from social signals also had an advantage in correctly determining their chances to compete for the high status role of a leader (i.e., is it worth trying to become the alpha now or wait a while?). Lastly, a higher sensibility for leader cues allowed group members to immediately monitor, learn from, and coordinate with individuals worthy of following (Henrich & Gil-White, 2001).

Second, an embodiment perspective on leadership suggests that abstract concepts such as leadership prototypes are stored modally in human brain structures (Reh et al., 2017). This means that the perception of embodied leadership signals—such as bodily gestures and postures, facial expressions, physical characteristics (Küpers, 2013)—may trigger bodily reactions of the observer (Reh et al., 2017; Schubert & Koole, 2009) such as directing his or her sense systems toward the source of the signals (i.e., the emergent leader). This is not to say that leader signals cannot also activate more complex cognitive evaluation patterns; yet, our reasoning here focuses on the habitual and automatic cognitive reactions that have evolved in the past because they increased people's survival chances. The communication abilities of this "early human mind" are likely to be limited to simple signs (Pentland, 2010), meaning that embodied signals may trigger short-term automatic reactions in observers. As the two-part model of the human brain (Kahneman, 2011) vividly describes, these unconscious processes complement humans' attentive and largely conscious mind.

In line with this two-system perspective of the human brain (Kahneman, 2011), evolutionary theory suggests that adaptive behavioral mechanisms exist at both levels of cognition (i.e., higher forms of reasoning and lower-level, automatic processes of attention). However, research so far has mostly focused on the more complex cognitive processes resulting in leadership perceptions (Maner et al., 2008). For instance, a laboratory study showed that naïve observers can draw inferences about emergent leadership both from verbal and nonverbal cues when watching 20-minutes videotaped student group interactions (Stein, 1975). Yet, observers in this earlier work could rely on rather long time-frames with rich behavioral indicators for deriving assumptions about leadership through comprehensive cognitive information processing. In contrast, our research integrates evolutionary signaling theory, an embodiment perspective, and social attention theory to provide an explanation why observers should also be able to grasp leadership cues on a more basic, automatic attention level.

Social attention theory

Humans evolved as group-living animals (Darwin, 1871), such that most of the time we were surrounded by other people. In this environment, it was helpful for individuals to pay attention to others' behaviors and to interpret social signals appropriately. These skills allowed individuals to become an accepted member of a group and to obtain a fitness advantage over fellows who were less socially attentive (Klein et al., 2009; Van Vugt et al., 2008). As one consequence of this need to be socially attentive, living in large groups has given a selection advantage to the development of an elaborated system of visual signal detection (Emery, 2000) that allowed individuals to recognize each other, to communicate their mental states, and to predict their fellows' behavior (Frischen, Bayliss, & Tipper, 2007).

Over 30 regions in the primate brain are related to the processing of visual information—a quite sophisticated procession system compared to other vertebrates (Emery, 2000). Humans make three to five eye movements per second, on average (Holmqvist et al., 2011). This results in a large amount of visual information and requires visual processing to occur in a selective manner in order to fulfill its functionality of helping humans tackle the challenges of social life in an effective way (Maner et al., 2008). Thus, the sense system should be biased to readily detect those signals that are relevant to solving specific adaptive problems in group settings such as selecting a leader to follow. This evolution-grounded functionality of the visual attention system makes eye gazing patterns uniquely suited for capturing attention to leadership signals.

Eye-tracking methods can capture individuals' reflexive orientation toward a stimulus (i.e., reflexive saccades) or spontaneous eye gaze patterns (i.e., scan paths) during the observations of complex stimuli, such as social interactions in group meetings (Eckstein, Guerra-Carrillo, Singley, & Bunge, 2017). Individuals cannot perceive everything in the visual field with equal attention; rather they can only process one central region with high acuity (i.e., focalized concentration, cf. Eriksen & Yeh, 1985). This implies that when watching a group interaction, individuals need to fixate on someone or something and their focus of attention can be clearly determined. Hence, in contrast to observers' cognitively constructed perceptions of leadership, eye gazing patterns provides a moment-to-moment indicator of people's rapid and automatic attentiveness to leader cues.

Given that social gaze has evolved as a functional system helping individuals to survive in social settings by focusing on cues of relevance, we assume that people's eye-gazing patterns should reflect an evolved attention bias toward leadership signals. Whereas the number of fixations captures the orienting component of attention (i.e., how often does a participant gaze at someone or something?), the duration of fixations (i.e., how long does a participant gaze at someone or something?) reflects the observer's attentional engagement (Nummenmaa, Hyönä, & Calvo, 2006). In other words, whereas the number of fixations points to the pertinence of a stimulus to attract attention, the duration indicates how informative or interesting the fixated stimulus is. To illustrate, an evolved signal may attract an observer's initial eye gaze attention (i.e., the observer is fixating the stimulus), but the stimulus may immediately turn out to be irrelevant such that the observer's attention shifts straightaway (i.e., low duration of fixation). In contrast, when the stimulus triggers a high attentional engagement because it contains valuable information, the observer may fixate it for a long duration.

Hypotheses and research questions

To summarize our line of reasoning, we propose that some individuals emerge as leaders in initially leaderless groups, and that these individuals attract more attention of naïve observers than non-leaders. We expect this attention effect to be reflected in both the orienting component (i.e., fixations) and the attention engagement (i.e., duration) of naïve observers' eye gazing patterns when watching thin slices of behavior from team interactions. Stated formally, we hypothesize:

Hypothesis 1. *Naïve observers will fixate on emergent leaders more often than on non-leaders.*

Hypothesis 2. *Naïve observers will gaze at emergent leaders for longer than at non-leaders.*

As pointed out earlier, research has paid much attention to emergent leaders' individual characteristics (Wellman, 2017). One of the most salient characteristics that played a role in evolution is individuals' sex; yet, evidence so far is inconclusive when it comes to gender differences in emergent leadership ascriptions (e.g., Eagly & Carli, 2003). On the one hand, some research states that females are less likely to attract the attention of others and thus less likely to emerge as leaders (e.g., Aries, 1996; Butler & Geis, 1990). On the other hand, some scholarly work negates any sex effects (e.g., Schneier & Bartol, 1980) and some studies even argue for a female advantage in leadership attention, for example in cultures with low norm strength and few social sanctions (Toh & Leonardelli, 2012) or in situations of low to moderate conflict (Vongas & Al Hajj, 2015).

Providing evidence for an attention advantage of male emergent leaders, evolutionary psychologists have repeatedly emphasized that men are more likely than women to be ascribed leadership potential because they possess a physical advantage (strength and power), which has increased the group's survival chances in the ancestral past (Goktepe & Schneier, 1989; Van Vugt et al., 2008; Wentworth & Anderson, 1984). Masculine facial or bodily features are signals for higher testosterone levels, which in turn increase the likelihood to act in a dominant and aggressive manner (Carré, McCormick, & Mondloch, 2009; Grabo et al., 2017). These attributes may have been beneficial for groups in situations of intra- or intergroup conflict. For instance, a more powerful and aggressive leader can protect the group when it is under attack (Spisak et al., 2012). In line with this notion, research found that a gaze cue of a dominant male face influenced observers' performance in an eye-tracking task more comprehensively across contexts than a non-dominant female face (Ohlsen, van Zoest, & Van Vugt, 2013). To summarize, the evolutionary perspective suggests that male emergent leaders may have an evolved attention advantage over female emergent leaders.

On the other hand, research in the tradition of a competence signaling perspective has argued that perceptions of competence constitute the central mechanism that determines the amount of leadership ascribed to team members (Wentworth & Anderson, 1984). Indeed, studies indicate that the positive relationship between physical cues and leadership ascription is mediated by perceptions of competence and intelligence (Bellew & Todorov, 2007; Blaker et al., 2013; Todorov et al., 2005). When observing dynamic team situations, individuals consider a variety of verbal and nonverbal signals to derive assumptions of team members' competence, and physical cues can lose relevance in comparison to more salient verbal and nonverbal signals of competence. For instance, women are ascribed higher leadership potential in peaceful situations compared to settings of intergroup conflict because physical cues cannot add an advantage to group survival in no-threat situations (McDonald, Navarrete, & Van Vugt, 2012; Van Vugt & Grabo, 2015). Overall, this research stream suggests that female emergent leaders may not suffer from an attention disadvantage but attract at least the same amount of attention (if not even more) than male emergent leaders in no-threat situations (such as the group discussion setting examined in this study).

Taking into account that both perspectives provide compelling arguments, we refrain from hypothesizing and instead pose the following research questions:

Research Question 1. *Do naïve observers fixate male emergent leaders and female emergent leaders equally often?*

Research Question 2. *Do naïve observers gaze at male emergent leaders and female emergent leaders equally long?*

Methods

Stimuli

The stimuli for this experiment were obtained from a prior study in which we videotaped meetings of 42 zero-history teams working on a consulting project for a large automotive company. The teams collaborated for seven weeks and had to deliver a final presentation in front of the company's top management at the end of the consulting project.

We used a triangulated design to collect emergent leadership ratings at the day of the final presentation. The team themselves and two team mentors (who interacted with the teams during the project but were not present during the videotaped team meetings) were asked to name one of the team's members who they thought emerged as an informal leader during the project. Thus, each team member received either a 0 (no leader) or 1 (emergent leader) rating from the three sources, which we aggregated to an overall emergent leadership rating. For the purpose of this study, we selected seven teams consisting of three persons with one clear emergent leader (i.e., one person who had been identified as the emergent leader by the three rating sources). Members of the selected teams were born in 12 different countries, with German (33.3%), Chinese (9.5%), Georgian (9.5%), and Indian (9.5%) being the most prevalent nationalities.[2]

The videotaped team meetings showed the teams interacting while sitting at a quadratic table. The camera was positioned at one side of the room (see Fig. 1). We randomly selected two short video fragments (15,000 ms) from each original video (i.e., 2 fragments × 3 videos × 7 teams = 42 video stimuli in total). The fragments did have to meet particular requirements and if a randomly selected video sequence did not fulfill these criteria, we repeated the procedure until we reached the predefined number of video clips. The requirements were that (1) group members had to remain seated for the entire fragment, (2) members could not block each other from view, (3) no other persons or moving objects could be present in the scene, and (4) all group members needed to be engaged in the conversation, i.e., no monologues because research has shown that attention is more likely to be drawn to the person speaking, even if the observer cannot hear what the speaker is saying (Duncan & Fiske, 1977; Ho, Foulsham, & Kingstone, 2015). Furthermore, because observers have a tendency to pay more attention to the center (Tseng, Carmi, Cameron, Munoz, & Itti, 2009), non-leaders were seated in the middle position in 62% of the meetings.[3]

Eye-tracking experiment

Eye-tracking is a rather fine-grained observation method. To illustrate, a 1000 Hz eye-tracker records participant's gaze direction 1000 times per second. This means that a few participants in an eye-tracking experiment already generate thousands of data point – a challenge that has motivated scholars to develop big data analytical methods to effectively analyze eye-tracking data (e.g., Blascheck, Burch, Raschke, & Weiskopf, 2015). In our study, we rely on previous standards and use a sample size and clip length that is common in cognitive psychology (e.g., Duchowski, 2017; Jiang, Borowiak, Tudge, von Otto, & Kriegstein, 2017).

Eighteen paid Dutch volunteers (10 female; 8 male) with a mean age of 26.51 years (SD = 9.60 years) watched the 42 selected video clips (15,000 ms). The experiment was conducted in a sound-isolated and dimly lit room. Participants took on average 20 min to finish the tasks. All participants had normal or corrected-to-normal vision. The experiment was conducted in accordance with the guidelines of the Helsinki Declaration. After providing informed consent, participants received written instructions that asked them to pay close attention to the social interactions of the people in the videos.

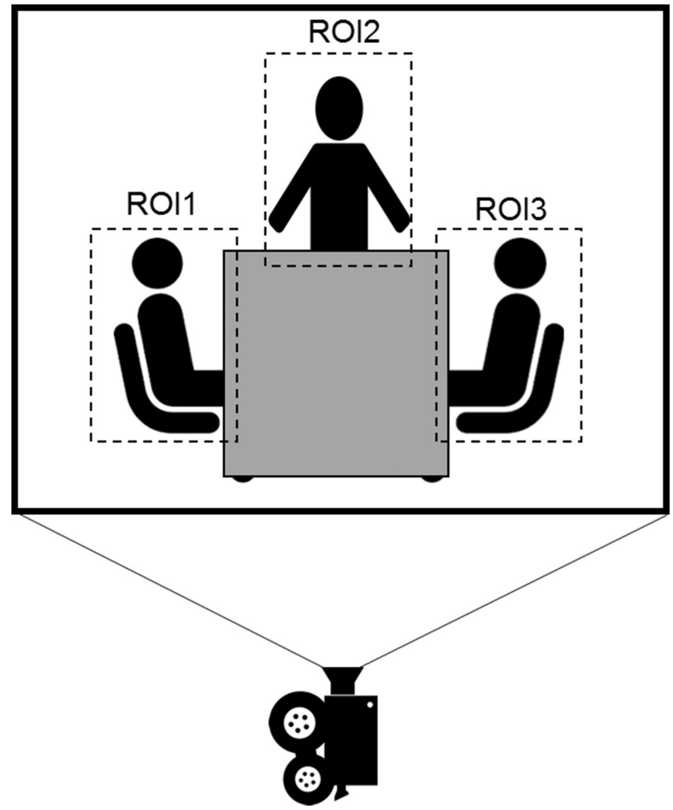

Fig. 1. Videotaping setup and definition of Regions of Interest (ROI) for the eye-tracking experiment. The video clips contained what is shown in the black box; the dotted lines indicate the ROIs used for determining people's eye-tracking patterns.

Thereafter the eye tracker was calibrated. Participants positioned their head on a chinrest at a distance of 75 cm from a 21-inch Samsung Syncmaster display (100 Hz) with a resolution of 1680 × 1050 px. The computer had an Intel Core 2 Duo (3 GHz) processor and an NVIDEA GeForce 210 video card. The task was programmed using the experiment-builder software OpenSesame (Mathôt, Schreij, & Theeuwes, 2012). Monocular movements were recorded with an Eyelink 1000 (Desktop Mount model, infra-red video-based, SR Research Ltd., Canada), with a resolution of 1000 Hz (temporal) and 0.01° RMS (spatial). The eye tracker contained an eye illuminator that classifies eye movements surpassing a 35°/s velocity or a 9500°/s^2 acceleration as saccadic movements.

Throughout the experiment, each trial started with a drift correction procedure, meaning that participants had to press a space-bar while they were fixating on a central cross on the screen. The video clip immediately followed. The 42 videos were played in random order and the sound was muted. The resolution of the videos was 720 × 576 px or 640 × 480 px. At random moments during the experiment, participants were asked to answer a simple question about the clip they just saw in order to ensure their sustained attention (e.g., “Is there a sheet of paper on the table?”). Participants answered these yes/no questions (8 questions in total, each concerning a unique team) by typing the response as Y (for yes) or N (for no) on a QWERTY keyboard.

Exploratory analysis: Non-verbal behavior coding

To investigate how non-verbal cues may link to a potential attention bias toward emergent leaders, we also coded team members' non-verbal behaviors in the 42 video clips. Given the limited sample size at the

[2] Nationality did not predict leader emergence ratings, $F(1,19) = 0.158$, $p = 0.696$.

[3] Our findings regarding naïve observers‘visual attention to team members in the videos remained significant when controlling for seating position (see Appendix A for details).

level of individual team members that resulted from our focus on thin slices of behavior (i.e., short video clips for the eye-tracking experiment), this part of our research was exploratory.

Important elements of nonverbal communication are (1) postural cues such as gestures and body movements and (2) facial expressions (Schyns & Mohr, 2004). We adapted a coding scheme from Bartel and Saavedra (2000) to measure these two dimensions with regards to active/approaching and passive/nervous expressions. Postural behavior was coded as (1) active postural indicators (active hand movements, expansive gestures, poised for action, constant body movement), (2) bodily orientation toward others (orienting toward group members, leaning forward, head directed toward group members), and (3) passive postural indicators (little movement in limbs or torso, expressions of boredom such as resting head on hands, head titled downwards, rubbing eyes). Facial expressions were coded as (1) active/friendly expressions (smile with teeth showing, closed lip smile, mouth turned upwards), (2) passive facial indicators (blank stare, yawning, little facial movement, fixed stare away, frown), and (3) expressions of nervousness (nervous smile, evasive eye contact).

We trained a research assistant on our coding scheme and double-coded five videos with an expert coder to ensure that satisfactory agreement (> 90% overlap) was reached. To reach an agreement on any dissenting codes, we went back to the code definitions and made a joint decision about which code to use. The research assistant coded the 42 video clips separately for each team member, meaning that for each video clip three coding files were created using Mangold Interact Software (Mangold, 2010). The research assistant watched the video and cut the video each time the focal team member showed a different nonverbal behavior that was then coded according to our coding scheme. We then merged all files to obtain the descriptive statics for the nonverbal behavior of the emergent leaders and the non-leaders.

Results

Eye gazing

We used (1) the amount of fixations as a proxy for the observers' orienting component of attention and (2) the length of each fixation as a measure for the observers' attentional engagement when watching the individuals in the clips. To capture the number and duration of fixations for each team member, the video clips contained 3 regions of interest (ROIs) capturing the three individuals (see Fig. 1). The surface of these interest areas was of equal size (100,000 px).

We first analyzed observes' general eye movements, showing that participants made on average $M = 32.78$ fixations ($SD = 4.26$) during each 15 second clip and each fixation on average lasted for $M = 419.54$ ms ($SD = 65.76$ ms). We then turned to the fixations of the targets (i.e., emergent leaders and non-leaders) and other objectives by using the ROIs. On average, participants made $M = 25.55$ fixations on the targets in the ROIs ($SD = 3.45$) and $M = 7.22$ fixations to objects outside the ROIs ($SD = 2.49$). This means that during each video clip, participants gazed on average at targets in the ROIs for $M = 11{,}071.09$ ms ($SD = 872.14$ ms) and spend $M = 2431.40$ ms ($SD = 738.96$ ms) on objectives outside the ROIs. We only focused on the fixations in the ROIs and compared the participants' average fixation and gaze duration of the leader ROIs with those of the non-leader ROIs (data files see http://dx.doi.org/10.17632/ngj7wbfxxm.1).

First, we collapsed the data at the participant level to calculate *t*-tests for paired samples. Particularly, we compared participants' mean fixations of emergent leaders compared to their average fixations of non-leaders as well as their average eye gaze duration at leaders versus non-leaders. Providing support for Hypothesis 1, the results showed that naïve observers gazed at emergent leaders ($M = 9.29$, $SD = 1.24$) more often than at non-leaders ($M = 8.22$, $SD = 1.24$), $t(17) = 4.416$, $p = 0.000$, $d = 0.871$. Second, in line with Hypothesis 2, naïve observers also gazed at emergent leaders longer during each fixation ($M = 4106.19$ ms, $SD = 408.67$ ms) than at non-leaders ($M = 3637.96$ ms, $SD = 321.80$ ms), $t(17) = 4.035$, $p = 0.001$, $d = 1.273$.[4] Table 1 summarizes the results of the paired *t*-tests.

To answer Research Questions 1 and 2, we compared observers' eye fixations and duration patterns for female emergent leaders (12 videos clips) with those for male emergent leaders (30 video clips). The descriptive statistics indicated that observers fixated on male emergent leaders more often ($M = 9.47$, $SD = 1.29$) than on female emergent leaders ($M = 8.84$, $SD = 1.41$) and gazed at male emergent leaders for longer ($M = 4130.96$, $SD = 419.51$) than at female emergent leaders ($M = 4044.28$ ms, $SD = 674.81$ ms). Yet, paired *t*-tests revealed that only the difference in the observers' number of fixations of male and female emergent leaders was statistically significant, $t(17) = 2.492$, $p = 0.023$, $d = 0.466$, whereas gaze duration did not differ significantly between male and female emergent leaders, $t(17) = 0.557$, $p = 0.584$, $d = 0.154$.

Non-verbal behavior

Our coding procedure resulted in 373 non-verbal behavior indicators extracted from the 42 video clips. In the following, we report the absolute number of emergent leaders' non-verbal behaviors compared to the average number of non-leaders' non-verbal behaviors (i.e., absolute number divided by two, because there were twice as many non-leaders as emergent leaders). These exploratory results showed more active postural indicators for emergent leaders ($M = 39$ incidents) than for non-leaders ($M = 20.5$ incidents, $SD = 3.54$) across all video clips. Furthermore, emergent leaders oriented more often toward other team members (46 incidents) than non-leaders ($M = 32.50$ incidents, $SD = 0.71$). With regards to passive postural indicators, emergent leaders ($M = 39$ incidents) and non-leaders ($M = 40.50$ incidents, $SD = 6.36$) showed similar behavioral patterns.

Turning to the facial expressions, the number of active/friendly facial expressions between emergent leaders (11 incidents) and non-leaders ($M = 9.50$ incidents, $SD = 2.12$) varied only slightly. Yet, whereas we could merely identify one incident of a passive facial expression for the emergent leaders, we found that non-leaders engaged in this type of behavior more often ($M = 10.00$ incidents, $SD = 1.41$). Similarly, with regards to expressions of nervousness, emergent leaders in our video clips did not display this type of behavior at all, whereas non-leaders at least occasionally engaged in such behavior ($M = 6.50$ incidents, $SD = 0.71$).

Discussion

This study integrated a signaling perspective as employed in evolutionary and embodiment theory with social attention theory from social cognitive science to argue that people rapidly and automatically pay visual attention to emergent leaders when watching natural team

Table 1
Results of the paired *t*-tests.

Comparison	*t*	*df*	*p*	*d*
Fixation emergent leaders ↔ non-leaders	4.416	17	0.000	0.871
Duration emergent leaders ↔ non-leaders	4.035	17	0.001	1.273
Fixation male emergent leaders ↔ female emergent leaders	2.492	17	0.023	0.466
Duration male emergent leaders ↔ female emergent	0.557	17	0.466	0.154

[4] We also ran a mixed-effects model (Judd, Westfall, & Kenny, 2012) that treated teams, time points, and the number of videos from each time point as random intercepts. The outcomes of the paired *t*-tests and the mixed-effects models are precisely the same (see Appendix A for the detailed results).

interactions. We collected emergent leadership ratings for three-person project teams and then used an eye gazing experiment to show that naïve observers gazed more often and for an average longer time period at emergent leaders, compared to non-leaders, when watching brief video clips of these teams.

A rich body of literature (e.g., Tskhay et al., 2014; Van Quaquebeke, Graf, & Eckloff, 2014) has put forth the idea that people draw inferences about leadership through a complex comparison process between the cues signaled by a target person (i.e., the emergent leader) and their own implicit theory of an ideal leader (i.e., their leader prototype). Yet, whereas previous research suggested that this process is "unlike simple judgements that require little inference" (Tskhay et al., 2014, p. 902), our findings indicate that the orientation toward emergent leaders can also occur rapidly, automatically, and without much deliberate thought. We interpret this attention bias in terms of an evolved mechanism for detecting leadership potential in fellow humans—the leader index (Grabo et al., 2017)—that has helped human beings in our ancient past to increase their survival chances.

Our findings suggest a slight initial attention advantage for male emergent leaders compared to female emergent leaders in terms of observers' reflexive orientation (i.e., number of fixations) but not with regards to their attentional engagement (i.e., eye gaze duration). Of note, the effect size for the sex differences in fixation was moderate, and the low number of female emergent leaders in our sample could potentially limit the reliability of our findings. Given the considerable amount of research pointing to the importance of contextual conditions for investigating sex differences in leadership, we consider it important that future research investigates whether changes in the context (e.g., cultural norm strength, Toh & Leonardelli, 2012; situations of intragroup conflict compared to peaceful environments, McDonald et al., 2012; Vongas & Al Hajj, 2015) or awareness of female leadership (Van Quaquebeke & Schmerling, 2010) affects people's automatic attention tendencies toward male compared to female emergent leaders.

Furthermore, our exploratory analysis of team members' nonverbal behaviors provides some initial answers to the question how emergent leaders signal their aspiration to lead in social interactions. Specifically, we explored the postural and facial expressions of the team members displayed in the 42 video clips. We found that emergent leaders, compared to non-leaders, showed a higher amount of active postures, more bodily orientation toward others and less passive facial expressions. In contrast, we did not find a substantial difference in the total number of passive postural indicators as well as active/friendly facial expressions of leaders and non-leaders. Overall, the findings indicate that emergent leaders seem to use a more active body language and express less facial passiveness than non-leaders. These results provide new impetus to early case studies on nonverbal behaviors, such as Baird's (1977) observation of a group discussion in which arm and shoulder movements were the strongest nonverbal predictors of emergent leadership, accompanied by intensive eye contact as well as head and facial agreement. Furthermore, scholars have successfully manipulated perceptions of charismatic leadership through nonverbal cues such as showing active face expressions and maintaining direct eye contact or using dynamic gestures and leaning toward others (Antonakis, Fenley, & Liechti, 2011; Shea & Howell, 1999).

We conclude from our exploratory non-verbal behavior coding that emergent tend to make themselves visible through multiple signals of activity. This conclusion fits well with results from the analysis of emergent leaders' verbal behaviors, namely the notion that emergent leaders tend to talk more than emergent followers (i.e., the "babble effect", Bass, 1954; Mullen, Salas, & Driskell, 1989). The emergent leaders' activity rate may indicate high commitment and interest in other team members, which, in turn, are expected to be functional for the team's problem-solving capabilities (Pavitt et al., 1997). Furthermore, a high activity degree can signal that persons showing these behaviors are—literally and physically—able to move a group (e.g., King et al., 2009; Van Vugt, 2017). The initiation of actions has been described as one of the main challenges for group survival (Van Vugt et al., 2008), thus pointing to the importance of proactive behavior as a signal for leadership potential. To conclude, we label our findings the "fidget effect" as a nonverbal equivalent to the "babble effect", meaning that team members who emerge into leader roles are more likely to signal their status through an active postural body language.

Directions for future research

This study provides a first step to develop a fine-grained conceptual model explaining how nonverbal, evolutionary predisposed leadership cues interact with more complex, verbal cues—both on an embodied and on a cognitive level—to predict attention toward emergent leaders in short- and long-term social settings (Grabo et al., 2017; Van Vugt & Ronay, 2013). As outlined earlier, we do not intend to challenge the view that leadership ascriptions can be the result of complex cognitive processes; however, it should also not be in question that shedding light on the basic mechanisms underlying leadership signaling detection has much to offer for a comprehensive theoretical understanding of leader emergence. In order to derive actionable insights for leadership practice (Antonakis, 2017), we believe the field needs theories that are precise in (1) defining concrete leadership signaling behaviors and (2) providing an explanation for why some leadership signals may be more important than others in attracting observers' attention.

In the following we contemplate new theoretical directions that can further our understanding of social attention and emergent leadership in teams. Noting that theoretical and empirical contributions often go hand in hand (van Maanen, Sørensen, & Mitchell, 2007), we also make suggestions for suitable methods from social cognition research that could test some of the ideas proposed here.

Interplay of leadership signals

Whereas several studies examined the separate effects of signals on leadership perceptions, scholars have only recently considered the joint influence of several cues (e.g., Batres, Re, & Perrett, 2015). Yet, the field so far lacks a theoretical explanation pointing out how several cues play together in determining the attention advantage of emergent leaders in dynamic social situations. Furthermore, from an empirical perspective, the field could profit from complementing self-report surveys of perceived leadership signals with eye-tracking methods that allow to capture fine-grained data about individuals' primary focus of attention in situations with various competing leadership cues. For example, an experiment could systematically vary physical cues such as height, body weight or facial attractiveness of (male and female) emergent leaders to see if these experimental conditions trigger differences in observers' eye-gazing patterns.

Gaze following

People monitor and follow the eye gaze of others because it provides useful information about potential threats and opportunities (Langton, Watt, & Bruce, 2000; Ohlsen et al., 2013). Thus, it would be of interest to analyze to what extent observers are guided by the eye gazing patterns of other team members in determining who leads (Frischen et al., 2007; Risko, Laidlaw, Freeth, Foulsham, & Kingstone, 2012). Such a research program could reconcile previous contradictory findings on social attention. On the one hand, some scholars have suggested that team members might look at the emergent leader more often, and naïve observers may simply follow members' gaze patterns as a source of information (e.g., Van Vugt et al., 2008). In contrast, humans might be able to quickly learn to ignore the gaze of followers. Capozzi, Becchio, Willemse, and Bayliss (2016) confronted observers with a learning task in which some faces were consistently displayed as leaders in one condition (i.e., they turned their gaze first, and the other faces followed their gaze). In the other experimental condition, the observers were confronted with followers only (i.e., two faces first shifted their gaze, and one face followed). The findings showed that only those faces who were displayed as leaders were successful in directing observers' social attention in the long-term. A combination of eye-tracking data from naïve observers along with team members' gaze cuing behaviors could clarify the role of non-leaders in determining the visual attention advantage of emergent leaders.

The role of socialization

To shed light on the question whether the attention bias toward leaders constitutes an evolved bias or is a result of socialization, it would be interesting to compare the eye gazing and gaze following patterns of children and adults when watching thin slices of social interactions. On the one hand, from an evolutionary perspective, we would expect that children are equally equipped with a fast recognition system for leadership cues as adults and thus re-running our study with children would obtain similar results (see also Antonakis & Dalgas, 2009). On the other hand, researchers in the tradition of a socialization perspective could argue that leadership cues are also culturally specific and thus children may only learn them over the course of their childhood. This perspective suggests that children may not show an attention bias toward emergent leaders compared to non-leaders. Furthermore, if the socialization approach turns out to be right, children should not show different fixation patterns toward male and female emergent leaders as they have not yet developed a gender-specific preference for leaders (Aries, 1996).

Automatic and strategic eye movements

Eye-gazing patterns of course do not always occur automatically but can be strategically regulated (i.e., people can intentionally draw their eye gaze toward a particular stimulus). Our study focused on studying naïve observers' eye-gazing patterns watching a naturally occurring interaction situation without any instructions to strategically move their eyes. The observers' eye-gazing patterns should thus reflect their automatic focus of attention; yet, we cannot entirely rule out the possibility that participants might have engaged in some form of strategic eye-movement. To investigate if participants develop hypotheses about the experimental task's purpose that may evoke strategic eye-gazing patterns, future research could explicitly ask participants after completing the study to indicate what they think the task was about. Furthermore, previous research provides evidence that individuals draw immediate visual attention toward evolutionarily relevant signals even under explicit instructions to attend to a concurrently presented neutral picture (Nummenmaa et al., 2006). Thus, future research could compare the eye-gazing patterns of observers who were explicitly instructed to pay attention to non-leaders with those of naïve observers who did not receive any additional instruction. Based on the present evidence, we expect that the initial fixation bias should still be higher for emergent leaders than non-leaders, even if participants are instructed otherwise—an assumption that would be interesting to test.

Observer characteristics

How do observers' individual characteristics influence selective visual attention? First, individual characteristics such as ethnicity (Chua, Boland, & Nisbett, 2005; Uono & Hietanen, 2015) can affect observers' gaze patterns when watching group interactions. In other words, although often overlooked, participants' cultural background may serve as a boundary condition influencing which leadership cues are perceived as particularly salient. For example, Chua et al. (2005) found that East Asians attend more to contextual information than people from Western countries when watching a static picture. This could also mean that individuals from Eastern cultures might show a slightly different attention pattern when watching emergent leaders in dynamic social situations.

Second, observers' attention preferences could be affected by their current living conditions. For example, previous research showed that women's relationship status and environmental scarcity affect gaze patterns when watching male faces. Using a facial masculinity/femininity preference task, Lyons, Marcinkowska, Moisey, Burriss, and Harrison (2016) compared the eye-gazing patterns of women in long-term romantic relationship to those of single women. Women were either primed with a high ('wealthy') or low ('scarcity') resource availability scenario before task completion. Single women showed longer first fixations on feminine rather than masculine faces when evaluating them as long-term partners in the wealthy condition. In contrast, women in a relationship had an increased preference toward masculine faces in the scarcity condition. These findings indicate that controlling for sex-related observer effects may be interesting in future studies.

Third, personality could also influence individual eye-gazing patterns. Past research using a target detection task showed that participants' extra-/introversion influences processing of others' eye gaze direction and emotional facial expression. Introverts reacted particularly strongly toward happy and neutral faces; extraverts were more likely to follow others' eye gaze when the stimuli faces were angry (Ponari, Trojano, Grossi, & Conson, 2013). Moreover, previous research found that social gaze processing (e.g., joint attention, eye contact, and gaze following) is impaired in people with autism (Emery, 2000). Hence, social skills may be essential for being able to detect leader cues. Future studies could examine such individual observer characteristics as potential moderators of observers' visual attentiveness to leader cues.

Performance consequences

From an evolutionary perspective, paying immediate attention to emergent leaders should have been adaptive, meaning it has increased individuals' survival chances (Grabo et al., 2017; Spisak et al., 2012; Spisak, O'Brien, Nicholson, & Van Vugt, 2015; Van Vugt & Ronay, 2013). This perspective implies that those persons who are looked at more often should ultimately turn out to be more efficient leaders. Future research can test this assumption by investigating whether observers' eye gazing patterns toward highly effective leaders differ from those toward ineffective leaders, such that emergent leaders who are successful in coordinating group efforts attract a higher amount of visual attention. To gain even more insights into the cognitive processes underlying this attention bias, scholars could also apply neuroscientific methods such as electroencephalogram technology to determine observers' level of cognitive engagement during the task, assuming that their engagement should be particularly high when effective (compared to less effective) leaders are acting in the video clips (Waldman et al., 2013).

Conclusion

This study integrated evolutionary signaling theory with a social attention approach to argue that people possess a highly automated mechanism for paying attention to leadership cues. We hope that our findings will inspire future research to develop a comprehensive model of emergent leaders' attention advantage. On a more general level, we emphasize that combining innovative measurement techniques from other disciplines with more traditional leadership theories offers a promising avenue for advancing our understanding of emergent leadership in dynamic social interactions. Eventually we can observe a lot by just watching.

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Table 2
Paired samples statistics ($N = 18$).

		M	*SD*	*SD* Error
Pair 1	Fixation emergent leaders	9.294	1.236	0.291
	Fixation non-leaders	8.218	1.235	0.291
Pair 2	Duration emergent leaders	4106.193	408.665	96.323
	Duration non-leaders	3637.962	321.804	75.850

Table 3
Estimates of fixed parameters ($N = 1.512$), dependent variable: eye gaze fixations.

	Margin	*SD* Error[1]	z	$p > \|z\|$	95% confidence interval	
					Lower bound	Upper bound
Leader	1.076	0.244	4.42	0.000	0.598	1.554
Intercept	8.218	0.291	28.23	0.000	7.647	8.788

Notes. 1) Robust standard error.
Stata syntax: mixed Fix i.Ldr || SubNr: || Team: || Time: || Rep: vce(robust).

Table 4
Cluster-robust estimates for marginal effects (N = 1.512), dependent variable: eye gaze fixations.

	Margin	*SD* Error[1]	z	$p > \|z\|$	95% confidence interval	
					Lower bound	Upper bound
Leader	9.294	0.291	31.90	0.000	8.723	9.865
Non-Leader	8.218	0.291	28.23	0.000	7.647	8.788

Notes. 1) Delta method standard error.
Stata syntax: . margins Ldr.

Table 5
Estimates of fixed parameters (N = 1.512), dependent variable: eye gaze duration.

	Margin	*SD* Error[1]	z	$p > \|z\|$	95% confidence interval	
					Lower Bound	Upper Bound
Leader	468.232	116.040	4.04	0.000	240.798	695.665
Intercept	3637.962	75.850	47.96	0.000	3489.299	3786.625

Notes. 1) Robust Standard Error.
Stata syntax: . mixed Dur i.Ldr || SubNr : || Team : || Time : || Rep: , vce(robust).

Table 6
Cluster-robust estimates for marginal effects (N = 1.512), dependent variable: eye gaze duration.

	Margin	*SD* Error[1]	z	$p > \|z\|$	95% Confidence Interval	
					Lower Bound	Upper Bound
Leader	4106.193	96.323	42.63	0.000	3917.403	4294.983
Non-Leader	3637.962	75.850	47.96	0.000	3489.299	3786.625

Notes. 1) Delta Method Standard Error.
Stata syntax: . margins Ldr.

Table 7
Overview of study variables in the data sets.

Name	Meaning
SubNr	Eye-tracking participant number (from 1 to 18)
Ldr	Leader (1) or non-leader (0)
Time	Time point of the video data collection (1, 2, or 3)
Rep	Fragment of the video (1 or 2)
Fix	Number of fixations in a video clip
Dur	Average duration of a fixation in a video clip

Notes. Data available online: http://dx.doi.org/10.17632/ngj7wbfxxm.1

Appendix A. Mixed-effects model

We ran a mixed-effects models with a cluster-robust estimate of the variance in Stata 14.1. The outcomes of the paired *t*-tests (see Table 1, sample statistics see Table 2) and the mixed-effects models for fixation (see Tables 3 and 4) and gaze duration (see Tables 5 and 6) at emergent leaders versus non-leaders are precisely the same. Data are available online (see Table 7 for an overview of the study variables in the data sets). Furthermore, to rule out an effect of group members' position at the table, we ran our mixed-effects model again and controlled for seating position (1 = not in the middle, 2 = in the middle of the table). The difference in fixations of emergent leaders versus non-leaders became even more pronounced, $t(18.015) = 7.630$, $p = 0.000$, as did the difference in eye-gazing duration, $t(18.015) = 7.060$, $p = 0.000$.

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