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'Eavesdropping' and perceived male dominance rank in humans

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Effects of social learning on mate preferences have been observed in a wide range of animal species, including humans. However, it is not known whether social learning also influences other important aspects of social perception in humans. We investigated whether 'eavesdropping', a form of social learning whereby observers extract information about individuals' qualities by observing their interactions with others, influences men's perceptions of the dominance of potential rivals. We found that observing the responses of other individuals modulates the perceived dominance of aggressors. Observers rated aggressors' dominance higher when they had previously observed others responding to the aggressor in a fearful, intimidated manner than when they had observed others responding to the aggressor in an angry, aggressive manner. By contrast with this finding for rated dominance, observing identical interactions did not affect observers' perceptions of the trustworthiness of the aggressors. The effect of observing others' responses on the perceived dominance of aggressors demonstrates that eavesdropping influences perceptions of dominance rank among men, which would be adaptive if it reduces the costs (e.g. risk of serious injury and/or loss of resources) that may be associated with acquiring knowledge of others' dominance rank via exclusively self-reliant learning. While previous research on social learning and sexual selection has focused on intersexual interactions (i.e. mate choice copying effects), our findings suggest that eavesdropping may also influence sexual selection for male traits via intrasexual competition.

Mate choice copying effects, whereby females increase relative preferences for previously less-preferred males after seeing them mate, have been demonstrated in a number of different nonhuman species (reviewed in Dugatkin 2000; Brown & Fawcett 2005; Galef & Laland 2005), including guppies, *Poecilia reticulata* (e.g. Dugatkin 1992; Dugatkin & Godin 1993; Godin et al. 2005), Japanese quail, *Coturnix japonica* (e.g. Galef & White 1998; White & Galef 2000; Ophir & Galef 2003a) and zebra finches, *Taeniopygia guttata* (Swaddle et al. 2005). These effects cannot be explained by changes to males' behaviour after pairing with females or females preferring locations where more conspecifics had been present (see Ophir & Galef 2003a, White 2004 and Brown & Fawcett 2005 for discussion) and can generalize to preferences for novel males that are physically similar to the paired male (White & Galef 2000; Godin et al. 2005; Swaddle et al. 2005). While orthodox models of sexual selection have emphasized genetic influences on female mate preferences (e.g. Andersson 1994), mate choice copying effects suggest that social transmission of mate preferences may also contribute to sexual selection for male traits (Kirkpatrick & Dugatkin 1994; Laland 1994; Brown & Fawcett 2005; Galef & Laland 2005). Indeed, mate choice copying may be adaptive when there is a cost (e.g. time, energy) to evaluating the quality of potential mates or when discriminating between the quality of potential mates is difficult (Wade & Pruett-Jones 1990).

The experiments described above demonstrate effects of social learning on females' mate preferences in a variety of nonhuman animals. More recent experiments have demonstrated analogous effects of social learning on attractiveness judgements in human observers (Jones et al. 2007a; Hill & Buss 2008; Little et al. 2008; Gilbert et al. 2009). For example, Jones et al. (2007a) found that observing other women with smiling (i.e. positive) expressions looking at male faces increased women's preferences for those men to a greater extent than did observing women with neutral (i.e. relatively negative) expressions looking at the same male faces.

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Other experiments have shown that pairing individuals with opposite-sex partners increases their attractiveness (Hill & Buss 2008), particularly when the opposite-sex partners are physically attractive (Little et al. 2008; Yorzinski & Platt 2010). Consistent with these findings, participants' responses to partners in speed dates are influenced by public information about how enjoyable others found the company of those individuals (Gilbert et al. 2009). Collectively, these findings suggest that social learning influences attractiveness judgements of opposite-sex individuals and, potentially, mate preferences (Jones et al. 2007a; Hill & Buss 2008; Little et al. 2008; Gilbert et al. 2009).

While recent experiments have presented compelling evidence that social learning influences attractiveness judgements and/or mate preferences in humans (e.g. Jones et al. 2007a; Hill & Buss 2008; Little et al. 2008; Gilbert et al. 2009), the extent to which other fundamentally important social attributions may be similarly shaped by social learning is currently unknown. Many researchers have emphasized the importance of dominance attributions for social behaviour in many nonhuman animals (Waitt et al. 2003; Reby et al. 2005; Shepherd et al. 2006; Ghazanfar et al. 2007) and humans (e.g. Mueller & Mazur 1996; Puts et al. 2006; Fink et al. 2007; Oosterhof & Todorov 2008; Sell et al. 2009). Indeed, there is good evidence from the fossil record that aggressive conflict was a significant selection pressure on human evolution (Manson & Wrangham 1991; Keeley 1996; Bowles 2009). To date, however, research on dominance in humans has focused almost exclusively on identifying either physical cues that influence perceptions of others' dominance, such as masculine characteristics in human faces and voices (e.g. Perrett et al. 1998; Feinberg et al. 2006; Puts et al. 2006; Boothroyd et al. 2007; Main et al. 2009; Jones et al. 2010a, b), or traits that are correlated with these cues, such as indices of physical strength, physical aggression, reproductive potential and social status (e.g. Mueller & Mazur 1996; Rhodes et al. 2005; Puts et al. 2006; Fink et al. 2007).

Exclusively self-reliant learning of others' dominance through direct experience (e.g. by engaging in aggressive conflict) may be costly because aggressive conflicts can result in serious injury and/or loss of resources (e.g. Sell et al. 2009; Watkins et al. 2010a, b). Moreover, although research has identified a variety of physical cues to others' dominance (reviewed in Watkins et al. 2010a, b), the correlations between these characteristics and indices of actual dominance are far from perfect, suggesting that relying solely on physical cues to dominance may be a somewhat poor strategy for assessing the dominance of individual competitors. For example, Fink et al. (2007) found that dominance ratings of men's faces explained only ca. 14% of the variance in their upper body strength. Additionally, although Carre & McCormick (2008) demonstrated the existence of facial correlates of aggressive personality in men, these cues only explained between ca. 9% and ca. 29% of the variance in men's aggression (depending on the sample and/or the measure of aggressive personality used).

Social learning could help to overcome the problem of how to identify dominant individuals by providing critical additional information about the qualities that others might possess and how they might behave. However, we know of no previous studies that have examined whether social learning can influence human's perceptions of rivals' dominance. This is, perhaps, surprising since observing how conspecifics respond to aggressors (i.e. eavesdropping) influences subsequent responses in some nonhuman animals (reviewed in Ophir & Galef 2003b; Griffin 2004; Kendal et al. 2005). Thus, eavesdropping, a form of social learning whereby observers extract information about individuals' qualities by observing their interactions with others, is a form of social learning through which individuals might acquire information about others' dominance (Van Schaik 2010). While social learning could provide important information about others' dominance, there can also be substantial costs to using information acquired by observing others' behaviour. For example, strategies for acquiring information that are overly reliant on social learning can cause erroneous information to be rapidly transmitted through the group, sometimes to the detriment of efficient behaviour (for a discussion of the problems associated with these informational cascades, see Giraldeau et al. 2002). Such issues may bias against the use of information acquired via social learning when assessing others' dominance.

In light of the above, we conducted an experiment to test whether eavesdropping influences perceived dominance rank in men. The experiment consisted of two parts. In an initial observation phase, male participants watched a slideshow in which men displaying angry expressions (i.e. aggressors) were paired with other men (i.e. responders) who responded to the aggressor in either an aggressive (i.e. angry) or intimidated (i.e. fearful) manner. After watching this slideshow, participants rated the dominance of the aggressors. We predicted that participants would rate the aggressors as more dominant after observing the responders responding in an intimidated, fearful manner than after observing the responders responding in an aggressive, angry manner. Such results would demonstrate that eavesdropping influences perceptions of dominance rank among men, since the only cues that can be used to distinguish between the two groups of aggressors are the responders' responses.

In addition to investigating whether observing how responders respond to aggressors affects perceptions of their dominance, we investigated whether perceptions of the aggressors' trustworthiness were similarly affected. We compared the effects of observing responders' responses to aggressors on perceptions of dominance and trustworthiness in light of recent research suggesting that these perceptions are orthogonal (Oosterhof & Todorov 2008). If the effects of observing responders' responses to aggressors are primarily related to perceptions of dominance rank, we would expect watching the slideshow to affect dominance perceptions but not necessarily to affect perceptions of trustworthiness.

METHODS

Stimuli

Front-view images of eight men with neutral expressions were randomly selected from the Karolinska directed emotional faces (KDEF) image set (Lundqvist & Litton 1998) for use in the face perception test that followed the observation phase of the experiment. These eight images were split into two groups of four images (Group A and Group B) that were approximately matched in terms of their perceived dominance using ratings (1 = not very dominant, 7 = very dominant) provided by 25 men who did not participate in the main experiment (mean age $\pm$ SD = 22.9 $\pm$ 5.0 years). The approximate matching consisted of ensuring that, for a given face assigned to one group, a face that was similar in terms of its average rated dominance was assigned to the other group. The mean absolute (i.e. unsigned) difference in rated dominance for these face pairs was 0.06 (SD = 0.05).

For each of the eight men to be shown in the dominance perception test, left-profile images with angry expressions were also obtained from the KDEF image set for use in the observation phase of the experiment. These individuals were designated the aggressors. The other images that were used in the observation phase of the experiment were left-profile images of a further eight males (the responders) with angry expressions and left-profile images of these same individuals with fearful expressions. The images of these additional males were randomly selected from the KDEF image set. Right-profile versions of all left-profile images, both aggressors and responders, were manufactured by mirror

flipping each of the left-profile images around their central horizontal vertical axis. Each of the eight aggressors was then randomly paired with one of the responders.

Procedure

One hundred and twenty-four men took part in the experiment (mean age $\pm$ SD $= 22.7 \pm 3.2$ years). The experiment consisted of two parts: an initial observation phase, where participants watched a slideshow in which the eight aggressor–responder pairings were presented, and a test phase, where participants rated either the dominance or the trustworthiness of the front-view, neutral images of the aggressors.

In the observation phase, the eight aggressor–responder pairs were presented so that the aggressor and responder appeared to be facing each other (i.e. each pair consisted of a left-profile image and a right-profile image, see Fig. 1). Aggressor–responder pairs were presented for 4 s on each occasion. Each pair was presented twice (i.e. the observation phase lasted for 64 s in total); once where the aggressor was shown in left profile and the responder was shown in right profile and once where the aggressor was shown in right profile and the responder was shown in left profile. Showing each pair twice in this way controls for possible effects of side biases in visual attention (Uttl & Pilkenton-Taylor 2001) and/or expression processing (Burt & Perrett 1997) during the observation phase. The order in which aggressor–responder pairs were presented was fully randomized. Importantly, while the aggressors were always shown with angry expressions in the observation phase, the facial expressions of the responders were manipulated. For half of the participants, the responders paired with the Group A aggressors

Figure 1. Examples of aggressor–responder image pairs shown in the observation phase of the experiment. The aggressor is shown in the left image and the responder in the right image of each row. (a) The responder responding to the aggressor in an aggressive manner (i.e. with an angry expression). (b) The responder responding to the aggressor in an intimidated manner (i.e. with a fearful expression).

were shown with angry expressions (i.e. they appeared to be responding to the aggressors' anger in an aggressive manner) and the responders paired with the Group B aggressors were shown with fearful expressions (i.e. they appeared to be responding to the aggressors' anger in an intimidated, fearful manner). For the other half of the participants, the responders paired with the Group A aggressors were shown with fearful expressions and the responders paired with the Group B aggressors were shown with angry expressions. Showing pairs of responders and aggressors in this way (i.e. with the emotional expression of the responders being manipulated while that of the aggressors is held constant) is similar to the paradigm that Jones et al. (2007a) used to demonstrate effects of social learning on human face preferences and ensures that both the aggressors' physical appearance and apparent behaviour are perfectly matched between learning conditions.

Immediately after the observation phase, participants completed a face-rating test, in which the front-view images of the eight aggressors with neutral expressions were shown in a fully randomized order. Sixty-two of the participants rated the dominance of the aggressors using a 1 (not very dominant) to 7 (very dominant) scale. The other 62 participants rated the trustworthiness of the aggressors using a 1 (not very trustworthy) to 7 (very trustworthy) scale. Many previous studies have used this type of rating paradigm to assess perceptions of men's faces (e.g. Mueller & Mazur 1996; Fink et al. 2007; Main et al. 2009). Having different groups of participants rate trustworthiness and dominance avoids possible problems with carryover effects, which may occur when the same participants rate the same individual multiple times (Rhodes 2006).

The experiment was run online. Previous studies have shown that online studies produce patterns of results for face perception that are virtually identical to those obtained in laboratory-based studies (e.g. Senior et al. 1999a, b; Jones et al. 2005, 2007b; Main et al. 2009). Following recommendations by Kraut et al. (2004), data from repeat IP addresses were not recorded, reducing the likelihood that participants could be included in the data set more than once. Kraut et al. noted that excluding data from repeat IP addresses in this way is a conservative way to control for possible repeated measures. Participants were recruited by following links from social bookmarking websites, such as www.stumbleupon.com.

All participants gave informed consent and the School of Psychology (University of Aberdeen) Ethical Review Committee approved all methods and procedures.

RESULTS

Interrater agreement for dominance and trustworthiness ratings was high in both groups of participants (all Cronbach's alpha > 0.82). For each participant who rated dominance, we calculated the average dominance rating they gave to aggressors who had been paired in the observation phase of the experiment with responders shown with angry expressions and the average dominance rating they gave to aggressors who had been paired in the observation phase with responders shown with fearful expressions. Corresponding values were calculated for the participants who rated trustworthiness. The distributions of these sets of scores were not significantly different from normal (Kolmogorov–Smirnov tests: all $Z < 0.91$, all $P > 0.38$).

Average ratings were first analysed using a mixed-design ANOVA with responder expression as a within-subjects factor that had two levels (angry, fearful), observation phase version as a between-subjects factor that had two levels (Group A aggressors paired with angry responders, Group A aggressors paired with fearful responders) and judgement type as a between-subjects factor that also had two levels (dominance, trustworthiness). This analysis revealed the predicted significant interaction between responder expression and judgement type ($F_{1,120} = 4.70$, $P = 0.032$, partial eta$^2 = 0.038$; Fig. 2). This interaction was not qualified by observation phase version ($F_{1,120} = 0.01$, $P = 0.91$, partial eta$^2 < 0.001$).

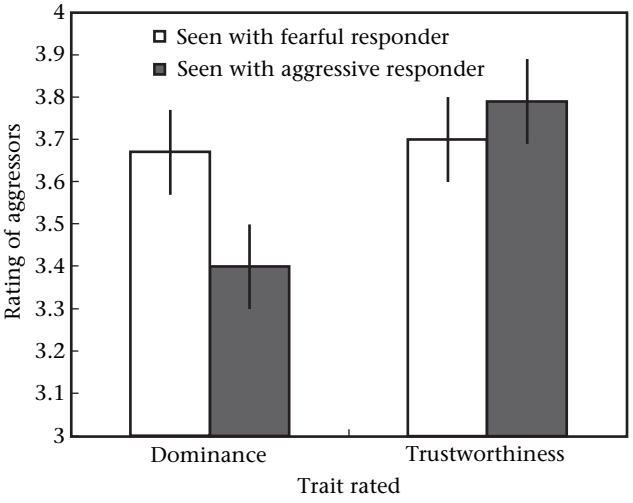

Figure 2. Ratings of dominance and trustworthiness of aggressors in relation to the facial expression of responders. Means are shown ±SEM.

Next, we repeated the analysis described above for dominance ratings only and without the factor judgement type. This analysis revealed the predicted significant main effect of responder expression ($F_{1,60} = 6.28$, $P = 0.015$, partial eta$^2 = 0.10$). As we had predicted, participants gave higher dominance ratings to aggressors they had previously seen paired with fearful responders (mean $\pm$ SEM $= 3.67 \pm 0.10$) than to aggressors they had previously seen paired with angry responders (mean $\pm$ SEM $= 3.40 \pm 0.10$). The significant main effect of responder expression was not qualified by an interaction between observation phase version and responder expression ($F_{1,60} = 1.22$, $P = 0.27$, partial eta$^2 = 0.02$), indicating that the significant effect of responder expression on dominance ratings reflected the experimental manipulation of the responders' responses and was not simply a consequence of differences in the aggressors' facial appearance between Groups A and B.

A corresponding analysis of trustworthiness ratings revealed no significant effects (all $F < 1.45$, all $P > 0.23$, all partial eta$^2 < 0.025$; Fig. 2). The mean trustworthiness rating for faces paired with fearful responders was 3.70 (SEM $= 0.11$) and the mean rating for faces paired with angry responders was 3.79 (SEM $= 0.14$).

DISCUSSION

Observing men responding to aggressors by displaying fearful facial expressions (i.e. appearing to be intimidated by the aggressors) caused the aggressors to be subsequently rated as more dominant than did observing men responding to the aggressors by displaying aggressive, angry facial expressions (i.e. appearing not to be intimidated by the aggressors). This effect of observing the nature of others' responses to aggressors on subsequent perceptions of aggressors' dominance demonstrates that eavesdropping influences men's perceptions of the dominance of potential rivals because the only cues that could be used to distinguish between the dominance of the two groups of aggressors were the responders' emotional responses seen during the observation phase of the experiment. Acquiring information about others' dominance ranks in this way (i.e. by eavesdropping, Van Schaik 2010) may be adaptive, as it could reduce the substantial costs (e.g. risk of serious injury and/or loss of resources) associated with acquiring

knowledge of others' dominance via exclusively self-reliant learning. That the effect of observing responders' responses to aggressors affected perceptions of dominance, but not perceptions of trustworthiness, suggests that the effect of fearful versus aggressive responses to aggressors may be relatively specific to perceptions of dominance and is also consistent with previous research showing that perceptions of dominance and trustworthiness are orthogonal (Oosterhof & Todorov 2008).

Importantly, the effect of others' responses to aggressors on subsequent dominance perceptions (i.e. the significant main effect of responder expression) did not interact with our counterbalanced factor (observation phase version). Consequently, the effect of responder expression on dominance ratings reflects the experimental manipulation of the responders' responses to the aggressors and cannot be explained by chance differences in the facial appearance of the aggressors between groups. While previous research on perceptions of men's dominance has emphasized the effects of cues of physical strength and physical aggression, such as exaggerated sex-typical characteristics in male faces (Perrett et al. 1998; Rhodes et al. 2005; Boothroyd et al. 2007; Fink et al. 2007; Main et al. 2009; Jones et al. 2010b), here we emphasize the effects of information about dominance rank that is acquired by observing interactions (i.e. eavesdropping). Previous research has also highlighted the possible effects of social transmission of mate preferences on sexual selection in humans and nonhuman animals (Kirkpatrick & Dugatkin 1994; Laland 1994; Brown & Fawcett 2005; Galef & Laland 2005; Jones et al. 2007a; Little et al. 2008). Our findings add an important dimension to such research by suggesting that social learning may also contribute to sexual selection via intrasexual competition. While we show here that eavesdropping influences perceptions of dominance among men, other researchers have highlighted the important distinction between dominance (i.e. status achieved through force or the threat of force) and prestige (status achieved by excelling in valued domains, Henrich & Gil-White 2001). Consequently, future studies comparing the contributions of eavesdropping to perceptions of dominance and prestige may shed light on the contribution of social learning to perceptions of status.

We systematically manipulated responders' responses to aggressors in our experiment to isolate the effects of eavesdropping on perceptions of dominance from the effects of the aggressors' physical appearance and behaviour. However, during natural social encounters, it is likely that the physical appearance of aggressors and others' responses will be correlated to some degree. For example, masculine facial characteristics in men are correlated with physical strength (Fink et al. 2007) and individuals who are the target of anger from aggressive, strong, masculine men are arguably more likely to respond in an intimidated fashion than those who are the target of anger from other types of men (Hess et al. 2000). Consequently, social learning of perceived dominance rank during social encounters may reinforce the positive correlation between physical appearance and perceived dominance in humans (Perrett et al. 1998; Boothroyd et al. 2007; Fink et al. 2007; Main et al. 2009; Jones et al. 2010b). That physical strength and aggression are also positively correlated with aspects of physical appearance in a wide range of nonhuman animals (reviewed in Archer 1988; Andersson 1994) raises the possibility that eavesdropping may also reinforce the effects of physical appearance on responses to aggressive confrontation in other animal species. Importantly, because the correlations between physical characteristics and indices of dominance are not perfect, combining information from physical cues with information learned by observing how other individuals respond to potential competitors may be an effective strategy for acquiring information about the dominance of potential rivals. Indeed, combining information from eavesdropping and information from physical cues when assessing others' dominance may also be important to reduce possible costs that may be associated with strategies for acquiring information that are overly dependent on social learning (e.g. informational cascades, whereby erroneous information can be rapidly passed on through a group, Giraldeau et al. 2002).

Although the effect that we observed in our experiment was relatively small, there are a number of reasons to suggest that it would be greater in more ecologically valid settings in which conditions for eavesdropping may be better. Because an initial observation (i.e. 'learning') phase preceded the test phase of the experiment, in order for responders' responses to affect perceptions of the aggressors' dominance, observers first had to recognize the aggressors (although this recognition need not necessarily penetrate consciousness; see, e.g. Tranel et al. 1995 for a discussion of conscious and unconscious face recognition). The appearance of the aggressors in the observation phase differed from their appearance in the test phase in two important ways, however. While the aggressors were shown in profile view and with angry expressions in the observation phase, front-view images of the aggressors with neutral expressions were presented in the test phase. Previous studies of face recognition have demonstrated that altering the viewpoint or emotional expression of images between learning and test phases significantly impairs, but does not eliminate, face recognition (e.g. Hill et al. 1997; Liu & Chaudhuri 2002; Chen & Liu 2009). Furthermore, face recognition improves as the time for which faces are presented during the learning phase is increased (e.g. Read et al. 1990) and each aggressor was presented for only 8 s during the observation phase of our experiment. Thus, our findings demonstrate that eavesdropping can influence perceptions of others' dominance even when conditions for learning and/or face recognition are suboptimal. Increasing the salience of the interaction by watching it in a real-world setting, rather than on a computer monitor, would also be expected to increase the magnitude of the observed effect. Finally, because categorical perception, whereby small variations in perceptions of a trait can trigger very different behavioural responses, is a feature of person perception (Beale & Keil 1995), the small observed differences in dominance ratings could well have relatively large effects on behavioural responses.

Our findings show that observing the nature of others' responses to aggressors influences subsequent perceptions of the aggressors' dominance, demonstrating that eavesdropping influences perceived dominance rank among men. This may be adaptive, given the potential costs associated with exclusively self-reliant learning of information about others' dominance and the imperfect correlation between physical cues and dominance in humans. Previous research on social learning and sexual selection has emphasized the possible effects of social learning on mate preferences (i.e. the role of 'mate choice copying effects', Kirkpatrick & Dugatkin 1994; Laland 1994; Brown & Fawcett 2005; Galef & Laland 2005; Jones et al. 2007a; Little et al. 2008). By contrast with this emphasis on intersexual interactions, our findings for eavesdropping, a form of social learning whereby information is acquired by observing interactions (Brown & Laland 2003), suggest that social learning may also influence sexual selection for male traits via intrasexual competition. We suggest that investigating the extent to which the observed effect of eavesdropping on perceptions of other men's dominance is conditional on factors such as cues that the aggressor is actually behaving aggressively, the availability of information regarding the responder's response or specific combinations of these factors is likely to be a fruitful topic for future research on human dominance perception. Additionally, we suggest that investigating how eavesdropping might be used to form and maintain dominance ranks in other species will similarly be a fruitful topic for future research.

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