**Distribution Agreement**

Where do gender stereotypes come from?
Testing a model of perceptual signaling

by

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Masters of Arts

Psychology

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An Abstract of
A thesis submitted to the Faculty of the
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in partial fulfilment of the requirements for the degree of
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Abstract

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The orthodox view of stereotypes is that they are culturally transmitted. Here, we propose and tested an alternative account based on perceptual transmission, whereby perceived facial dominance signals intelligence. In Experiment 1, adults (*N* = 55) rated computer-generated faces according to gender and various traits (e.g., dominance, attractiveness, and trustworthiness). More dominant faces were judged as smarter than less dominant faces and, crucially, dominance was the only variable that mediated the gender-intelligence link. In Experiment 2, we gave 6- to 10-year-olds (*N* = 88) a two-alternative forced-choice task where children judged which of two faces was smarter. Face pairs either differed in dominance, gender, or both. Children judged more dominant faces as smarter than less dominant faces. Moreover, they judged more dominant female faces as smarter than less dominant male faces. Suggesting a possible override of the cultural stereotype. These effects contrasted with judgments of niceness. Taken together, our findings suggest a specific role for facial dominance in signaling intelligence.



*Keywords*: Dominance, Intelligence, Stereotype Development, Gender Stereotype, Facial features

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## Introduction

Gender stereotypes are culturally pervasive. They are communicated in media (Sweet, 2014), through gendered marketing (Grau & Zoton, 2016), and via adults (e.g., parents and teachers) to children (Gunderson et al., 2012). Gender stereotypes, like stereotypes more generally, affect behavior (Czopp, Kay, Cheryan, 2015) and decision making (Chaxel, 2015). Gender stereotypes have even been found to negatively impact psychological well-being such as when individuals form negative views of the self (Bian et al., 2018). One type of gender stereotype is that men are better at math than women and, thus, fare better in Science, Technology, Engineering, and Mathematics (STEM) fields (Sun & Bian, 2021). It has been suggested that this stereotype hinders girls' math performance from early in development (Galdi et al., 2014; Tomasetto et al., 2011) and may even discourage girls from entering and participating in STEM fields (Shapiro & Williams, 2012). Given the potential influences on economic prosperity (Gupta et al., 2008) and mental health, understanding the etiology and development of stereotypes has become increasingly important.

Stereotypes develop early in life and are present in children (Ellemers, 2018). Of particular relevance to the present study is that, by 6 years of age, children have been found to endorse the stereotype that males are more intelligent than females (Bian et al., 2017), where participants identified a "really, really smart" person as male more often than female. In addition, when children were asked whether they wanted to play a game designed for smart individuals versus one for individuals who "try hard," boys showed significantly more interest in the former game, whereas girls preferred the latter. Although there is no evidence in support of a male advantage in STEM aptitude (Wang et al., 2013) or general intelligence (Mous et al., 2017), and explicit judgments may even favor females (Eagly et al., 2020), children appear to endorse the gender stereotype that males are more intelligent than females (Storage et al., 2020).

A widely accepted account of stereotypes is that they are culturally transmissed (Martin et al., 2014). In particular, the common view is that individuals adopt beliefs that are present in society. This claim is quite reasonable given that there are cases in which stereotypes are *explicitly* transmitted, such as when the doll Barbie uttered the phrase “math class is tough” (Reckard, 1992; Murnen, 2018) and boys are taught by parents to “not cry and be tough” (Epstein & Ward, 2011). However, gender stereotypes can also be transmitted *implicitly* through the differential treatment of boys and girls (Seavey et al., 1975; Sidorowicz, & Lunney, 1980), as when adults encourage boys to play with trucks, not dolls (Boe & Woods, 2018), or when teachers’ perception of gender and math ability influences children’s performance in math class (Robinson-Cimpian et al., 2014).

Although cultural transmission may address the *how* of stereotype development, it fails to answer the *why* question. That is, why do particular stereotypes, such as the gender stereotype about intelligence, develop? Research has shown that the stereotype that males are more intelligent than females can be found across cultures (Storage et al., 2020), suggesting some universality despite different cultural practices. Why might this be? In the present study, we address this question by investigating the role of face perception in intelligence judgments. By better understanding the underlying cause of why intelligence has been attributed to males more often than females, we will be in a position to better ameliorate the potential negative effects of this stereotype.

By looking at the development of the gender-intelligence stereotype, through perspectives from different fields, we propose a novel theory for why this stereotype may emerge in early childhood. We propose that this stereotype may develop because of a sensitivity to dominances. Starting early in ontogeny, both children and nonhuman animals are sensitive to dominance, distinguishing dominant individuals from submissive ones on the basis of physical features such as body size (Lourenco et al. 2016; Thompson et al., 2011), physical displays (Charafeddine et al., 2015; Charafeddine et al., 2020), and facial features (Cogsdill et al., 2014; Lefevre et al., 2014; Oosterhod & Todorov, 2008). Although some might argue that dominance is merely an indicator of physical strength (i.e., bigger individuals are stronger and thus more dominant), we suggest that dominance may also signal intelligence. Indeed, research shows that taller individuals are rated as more dominant than shorter individuals, and also more intelligent (Blaker et al., 2013). Moreover, it has been found that dominant individuals are more likely to receive a job promotion or higher salary than less dominant individuals (Graham et al., 2017; Mueller & Mazur, 1996). More dominant individuals are also more often associated with socioeconomic achievement and success than less dominant individuals (Hermanussen & Scheffler, 2016). Additionally, children are more likely to attribute more resources with dominant individuals (Charafeddine et al, 2015; Enright et al., 2017) and less dominant nonhuman animals are more likely to learn from and adopt practices from dominant individuals (Berry, 2011; Kendal et al., 2015).

Furthermore, researchers have studied the automaticity with which a brief exposure to an entity or action is used for making inferences, a phenomenon known as “thin-slicing” (Ambady, 2010; Murphy & Hall, 2021). One such area concerns faces (Willis & Todorov, 2006), even when faces are shown for only a fraction of a second (e.g., 150 milliseconds) and void of any contextual information, individuals are consistent in their inferences about personality traits and behavior (Olivola & Todorov, 2010). For example, individuals frequently use facial features to make inferences about dominance, competence, and trustworthiness (Todorov et al., 2015). It has also been shown that facial width-to-height ratio (fWHR) strongly correlates with dominance ratings such that the higher the ratio (shorter and wider), the stronger the dominance inference, with males having a higher fWHR than females on average (Geniole et al., 2015). This aligns with research showing that adults often rate male faces as more dominant than female faces (Oosterhof & Todorov, 2008). This thin-slicing phenomenon could suggest that the gender-intelligence stereotype may be based on very limited information such as perceptual dominance signals conveyed through the face, further highlighting potential factors other than gender that could influence our inferences about intelligence.

In the present study, we provide a twofold approach to testing whether dominance in faces can account for the gender-intelligence stereotype. In Experiment 1, we test this hypothesis using open-source data with adult participants (Oosterhof & Todorov, 2008) who rated faces on a number of traits and gender. If the judgment that males are more intelligent than females is rooted in dominance, then the perceived dominance of faces should mediate the relation between gender and intelligence. In Experiment 2, we test for an effect of dominance in children more directly by asking them to judge intelligence between two faces. If dominance accounts for the relation between gender and intelligence, then there are two predictions that follow on our task with children. First, they should judge faces that are more dominant as more intelligent. Although previous research has found that children as young as 3 years of age can judge faces according to “nice”, “strong,” and “smart” (Charlesworth et al., 2019), no research has directly tested whether dominance features in faces are used for judging intelligence. And second, children should weight dominance features more heavily than the culturally transmitted gender stereotype, which is that males are smarter than females.

## Experiment 1

In our first experiment, we assessed whether dominance mediates the gender-intelligence link using open-source data from adult participants' ratings of computer-generated faces, as described in Oosterhof and Todorov (2008). In this work, adults were asked to judge "competence", not "intelligence" *per se*, and although these two concepts may not be interchangeable, we use ratings of competence in this first experiment to assess whether dominance accounts for the relation between gender and competence, as a first step.

### Methods

We used publicly available data accessed through the Social Perception Lab database at Princeton University (http://tlab.princeton.edu/databases/randomfaces/; Oosterhof & Todorov, 2008). Data consisted of ratings from 55 participants for 300 computer-generated faces created in FaceGen 3.1 (see supplemental materials for examples of computer-generated faces). The computer-generated faces were scored on several dimensions including attractiveness, dominance, competence, trustworthiness, meanness, frightening, extroverted, likeableness, and threatening. All traits were scored on a scale from 1 (not at all [trait]) to 9 (extremely [trait]). In addition, each face was rated for the proportion of "maleness" to "femaleness" and given a score between 0 – 1 with 0.05 increments (0 being unambiguously male, and 1 being unambiguously female). Ratings for these faces are reliable (Carré et al., 2009; Todorov et al., 2008; Todorov et al., 2015).

### Results

Extant research provides support for a correlation between attractiveness and competence (Verhulst et al., 2010), which we replicated by conducting a correlation analysis with the current data set. As in previous research, faces rated as more attractive were also rated as more competent ($r$[298] = .789, $p < .001$). Given this association, we controlled for attractiveness in subsequent analyses.

*Partial correlations.* Controlling for attractiveness, we found a significant correlation between gender and competence, $r(298) = -0.304$, $p < .001$ (see Figure 1A), as reported by Oh and colleagues (2019). Faces rated as more male were also rated as more competent. Additional analyses revealed significant correlations between gender and dominance, $r(298)= -0.818$, $p < .001$ (see Figure 1B), and between dominance and competence, $r(298) = .408$, $p < .001$ (see Figure 1C), even when controlling for attractiveness. As expected, female faces are considered less dominant than male faces (Oh et al., 2019). Importantly, we also found that dominant faces are judged to be more competent than less dominant faces, suggesting a link between dominance and competence, not previously reported, at least to our knowledge. Moreover, to ensure that this link was not due to gender (given the significant correlation between dominance and gender), we controlled for gender (and attractiveness) in a subsequent analysis. Dominance and competence remained significantly correlated, $r(298) = .291$, $p < .001$.

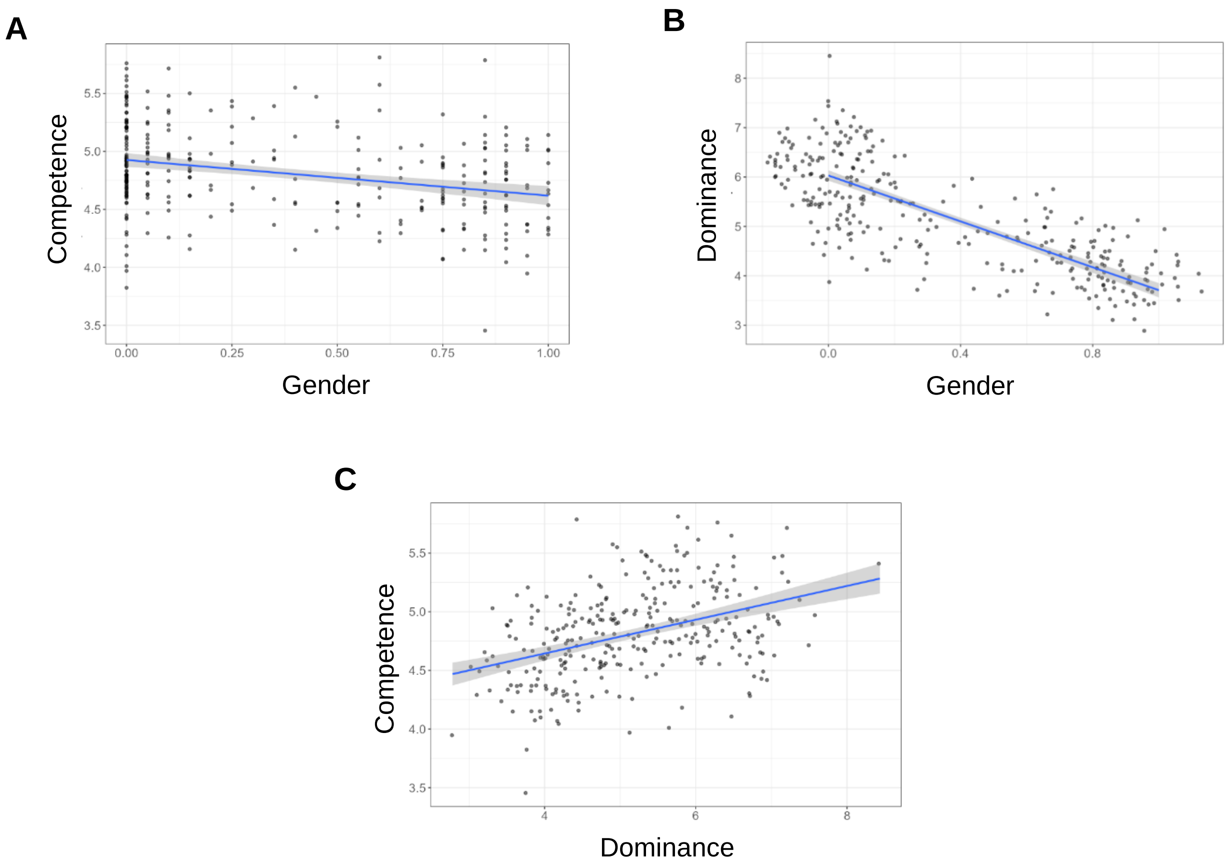


*Figure 1: Plots of the residuals for the variables of interest after controlling for attractiveness. (A) A significant negative correlation between gender and competence ratings, r(298) = -0.304, p < .001, where 0 = male and 1 = female. (B) A significant negative correlation between gender and dominance ratings, r(298) = -0.818, p < .001. (C) A significant positive correlation between dominance and competence ratings, r(298) = 0.408, p < .001.*

*Mediation analyses.* In the next set of analyses, we tested more directly for the role of dominance in the relation between gender and competence by using mediation analyses. Here, again, we controlled for attractiveness by including it as a covariate. Confidence intervals for direct and indirect effects were estimated using bias-corrected bootstrapping (2000 resamples). Our conclusions are based on whether the limits of the 95% confidence intervals (CIs) include zero, per recent recommendations (Hayes, 2017).

We conducted a mediation analysis with dominance as the mediator between gender and competence and found evidence of significant mediation (Figure 2A). In addition, to rule out model misspecification, we also conducted an analysis in which gender was used as the mediator. In contrast to the previous analysis, this analysis revealed no significant mediation (Figure 2B). Together, these analyses demonstrate that dominance accounts for the relation between gender and competence. In other words, men may be considered more competent than women because their faces are perceived as relatively more dominant.

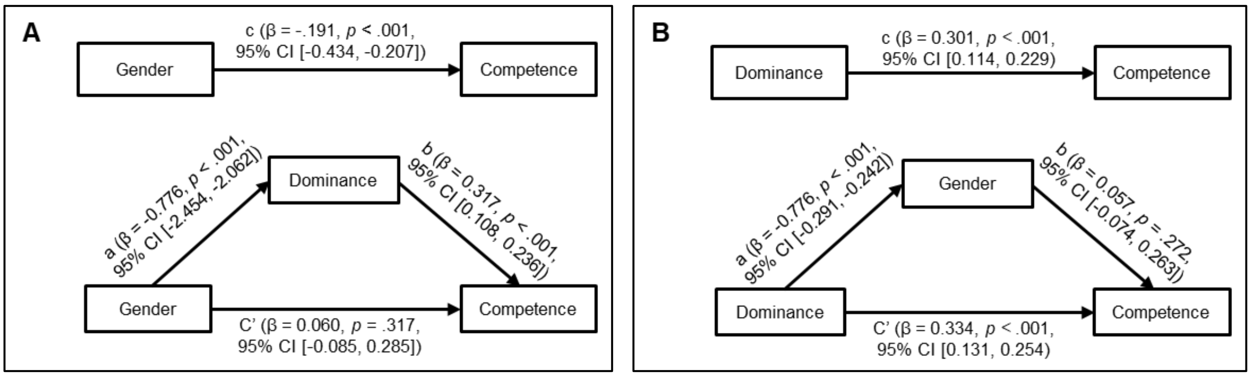


*Figure 2: Tests of mediation by dominance (A) or gender (B). A: The comparison between direct (top) and indirect (bottom) effects revealed significant mediation by dominance in the gender-competence relation. There were significant direct effects between gender and competence (top), gender and dominance (bottom), and dominance and competence (bottom). Whereas the c path was significant (top), the c' path was not significant (bottom), demonstrating full mediation by dominance. B: The comparison between direct (top) and indirect (bottom) effects revealed no mediation by gender in the dominance-competence relation. There were significant direct effects between dominance and competence (top), dominance and gender (bottom), and gender and competence (bottom). The c' path remained significant (bottom), like the c path, suggesting no mediation by gender. *Standardized betas are shown in this figure.*

To further test for the specificity of dominance in the gender-competence link in this dataset, we conducted additional mediation analyses with all other ratings: trustworthy, meanness, frightening, extroverted, likeable, and threatening. Although these variables correlated with dominance (see Table 1 in supplemental materials**),** no other trait served as a significant mediator—the direct link between gender and competence remained significant whether trustworthiness ($\beta = -0.251$, $p < .001$, 95% CI [-0.497, -0.271), meanness ($\beta = -0.212$, $p < .001$, 95% CI [-0.488, -0.222), frightening ($\beta = -0.218$, $p < .001$, 95% CI [-0.481, -0.235), extroverted ($\beta = -0.216$, $p < .001$, 95% CI[-0.507, -0.299), likeable ($\beta = -0.212$, $p < .001$, 95% CI [-0.421, -0.200), or threatening ($\beta = -0.206$, $p < .001$, 95% CI [-0.505, -0.183) served as the mediator.

Altogether, these findings suggest that dominance specifically accounts for the relation between gender and competence even when controlling for attractiveness (another feature that predicts competence judgments) or testing other traits as potential mediators.

## Experiment 2

In our second experiment, we examined the potential role of dominance in judgments of intelligence more directly. We also extend this research to children so as to begin to understand the developmental origins of such effects. We developed a task for children aged 6 to 10 years, in which they were questioned about which face in a pair of faces was more intelligent. As described in the Introduction, young children show sensitivity to dominance in faces and behaviors (Charafeddine et al., 2020; Cogsdill et al., 2014). They are also capable of making judgments about intelligence, though the gender stereotype only appears at about 6 years of age (Bian et al., 2017).

We predicted that if dominance influences children's intelligence judgments, then they should judge individuals with relatively more dominant faces as smarter. Moreover, if dominance overrides the link between gender and intelligence, then when dominance and gender are brought into conflict (i.e., the more dominant face is female and the less dominant face is male), children would continue to judge the more dominant face as smarter.

### Methods

**Participants.** A total of 96 children participated in this experiment. Eight children were excluded from data analyses for either not following instructions ($n$ = 6) or displaying a side bias ($n$ = 2). After exclusions, the final sample consisted of 41 girls ($M_{age}$ = 7.88 years) and 47 boys

$M_{age}$ = 8 years) – reaching the needed sample size indicated by an a priori power analysis calculated using jpower (Jamovi, 2020).

Children were recruited through the participant database maintained by the Child Study Center at Emory University and the Children Helping Science website (https://childrenhelpingscience.com/). Informed consent was obtained on behalf of children by their parents prior to participation. Upon completion of the study, all parents received an Amazon gift card for their children's participation. All procedures were approved by the Emory University Institutional Review Board (IRB).

**Materials.** Faces were real-life faces selected from a public stimulus set made available through the Open Science Framework (https://osf.io/ycv72/). These faces were manipulated on a dominance scale (for detailed methods, see Oh et al., 2020), such that each face could be characterized along a continuum in relation to a neutral face. Faces could vary from low dominant (-3 SD) to high dominant (+3 SD). In contrast to Experiment 1, in which adults rated computer-generated faces, we opted for real-life faces in this experiment with children because of the androgynous nature of computer-generated faces, which make gender identification difficult.

Faces used were -3 SD (low trait rating) and 0 SD (higher rating) away from the model face, which we reasoned would be sufficiently discriminable on the dominance continuum. We constrained the range of face dominance in this way to ensure that faces appeared relatively neutral in emotional expression. Only Caucasian faces were included. Faces were paired randomly per condition within condition constraints. All pictures of faces were 430 x 480 pixels.

**Design and Procedure**. Children were given a two-alternative forced-choice task (2AFC) designed to assess their use of facial dominance in judgments of intelligence and on the contrastive control of niceness (Qualtrics, 2021). We relayed two hypothetical scenarios to participants to ensure they understood the concepts of ‘intelligence’ and ‘niceness”. In the intelligence scenario, children were told a story about a puzzle that only one child, among many, could complete. We then asked participants to indicate whether the child who completed the puzzle was “smart,” “not smart,” or “I don’t know.” In the niceness scenario, children were told a story about a child who won a race but decided to share their trophy with everyone who ran the race. We then asked participants to indicate whether the child who won the race was “nice,” “not nice,” or “I don’t know.”

All children were subsequently tested in three different conditions of the 2AFC task, in which pairs of faces differed in either dominance (Dominance condition), gender (Gender condition), or both (Conflict condition) (see Figure 3). In the Dominance condition, face pairs consisted of half the trials being both male faces and the other half being both female faces. In the Gender Condition we showed two higher dominant faces together or two lower dominant faces together, divided equally among trials. All participants were shown a total of two blocks consisting of 21 trials each, for a total of 42 trials. The trials within each block were randomized between subjects for order and counterbalanced for face position such that if the low dominant or male face appeared on the left in one trial, the positions switched in another trial. On half the trials, children were asked a question about intelligence (i.e., “Which person is really smart?”), and on the other half, they were asked about niceness (i.e., “Which person is really nice?”).

All children were tested individually by an experienced experimenter over Zoom video conferencing on either their home computer (*n* = 71), tablet (*n* = 12), or mobile phone (*n* = 5). Children received a short break between blocks.

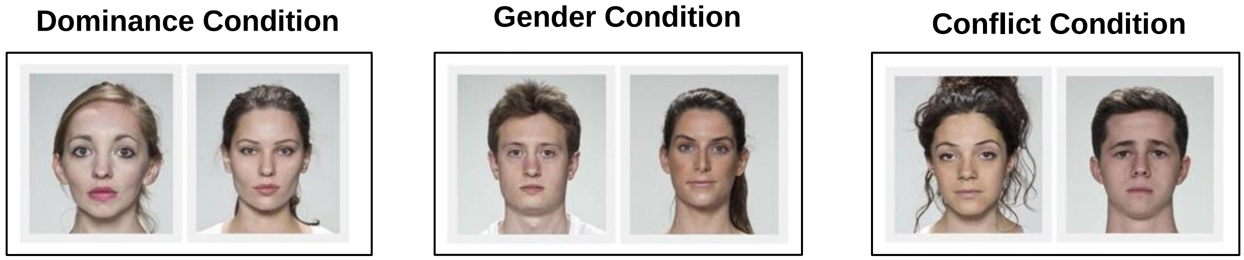


*Figure 3: Examples of face pairs across the three conditions. In the Dominance condition, faces were matched for gender (e.g., both female) but differed in relative dominance (low on the left and higher on the right – side counterbalanced across trials). In the Gender condition, faces were matched for dominance (e.g., both low) but differed in gender (male on the left and female on the right – side counterbalanced across trials). In the Conflict condition, the female face was high in dominance (left) and the male face was low in dominance (right) – side counterbalanced across trials.*

**Results**

In our hypothetical "smart" scenario, we had five children who responded, "I don't know" and in the hypothetical "nice" scenario one child indicated "I don't know". We ran an independent samples t-test and found no statistical differences between children who indicated "smart/nice" and "I don't know." Thus, none of these children were dropped from these analyses.

*Do children use dominance to judge intelligence?* A One sample t-test of children's judgments in the Dominance condition revealed that they chose the more dominant face as the "really smart" face significantly more often than chance ($M$ = .63, $SD$ = .22), $t(87) = 5.26$, $p <$ .001, $d$ =.561; 95% CI [0.078, 0.173] (see Figure 4A). A subsequent Analysis of Variance (ANOVA), with gender of the participant and gender of the stimulus faces as factors, revealed no significant effects of participant gender, $F(1, 86) = .015$, $p = .902$, $\eta^2 < .001$, or stimulus face gender, $F(1, 86) = .704$, $p = .40$, $\eta^2 = .020$. These findings suggest that neither participant gender, nor the gender of the stimulus faces influenced children's choices. We also found no statistically significant age effects, $F(4, 83) = 2.47$, $p = .051$, $\eta^2 = .106$. However, due to age nearing significance, an additional linear regression was performed to test weather age would predict choice. We found no significant age effects ($F(1, 86) = .008$, $p = .929$), with an $R^2 < .001$. Thus, boys and girls across the age range tested judged the more dominant face as smarter than the less dominant face, regardless of whether the pairs of faces were male or female.

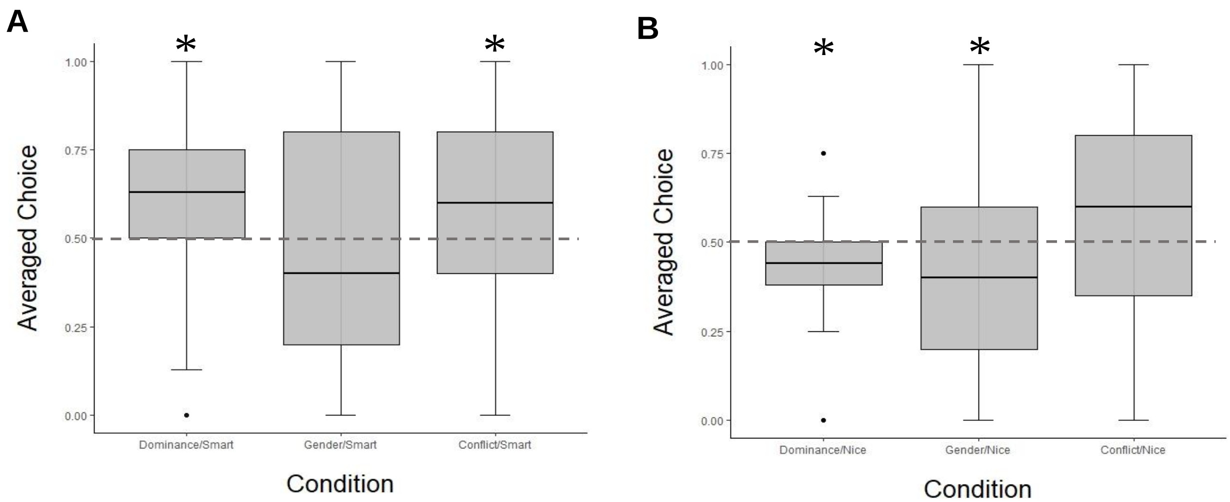


*Figure 4: Box-and-whiskers plots of children's judgments of intelligence (A) and niceness (B) in the Dominance, Gender, and Conflict conditions. When judging intelligence, children scored above chance in the Dominance and Conflict conditions, but not the Gender Condition (A). When judging niceness, children scored above chance in the Dominance and Gender conditions, but not the Conflict condition (B). Performance was calculated as the proportion of trials in which participants selected the 'correct' face according to the predicted pattern for the specific condition. In both Dominance and Conflict conditions, we coded the higher dominance face as "1" and the lower dominance face as "0". In the Gender condition, we coded male as "1" and female as "0". The y-axis indicates participants' proportion of responses for choosing the higher or lower coded face. The dotted line indicates chance performance.*

*Do children use gender to judge intelligence?* A One sample t-test of children's judgments in the Gender condition revealed that children chose male and female faces at equal rates when asked to select the "really smart" face ($M = .46$, $SD = .31$), $t(87) = -1.11$, $p = .27$, $d = -.118$; 95% CI [-0.101, 0.029] (see Figure 4A). A subsequent ANOVA, with participant gender and dominance of the stimulus faces (i.e., both low in dominance or both high in dominance) as factors, revealed no significant effects of participant gender, $F(1, 86) = .021$, $p = .885$, $\eta^2 = .038$, or stimulus face dominance, $F(1, 86) = 3.21$, $p = .077$, $\eta^2 = .044$. These findings suggest that neither participant gender, nor the dominance level of the stimulus faces, influenced children's choices. We also found no statistically significant age effects $F(4, 83) = .599$, $p = .664$, $\eta^2 = .028$.

Thus, boys and girls across the age range tested judged male and female faces as equally smart when there were no differences in dominance, and their own gender did not influence their judgements.

*Do children weight dominance over gender when judging intelligence?* A One sample t-test of children's judgments in the Conflict condition revealed that they chose the more dominant face as the "really smart" face significantly more often than chance ($M$ = .56, $SD$ = .25), $t$(87) = 2.21, $p$ = .029, $d$ =.236; 95% CI [0.006, 0.112] (see Figure 4A). A subsequent ANOVA, with participant gender as the independent variable, revealed no significant effect of participant gender, $F$(1, 86) = .075, $p$ = .785, $\eta^2$ = .001. These findings suggest that participant's own gender did not influence their responses. We also found no statistically significant age effects, $F$(4, 83) = .626, $p$ = .645, $\eta^2$ = .029. Thus, boys and girls across the age range tested judged the more dominant female face as smarter, with their own gender not influencing their choice.

*Do children use dominance to judge niceness?* A One sample t-test of children's judgments in the Dominance condition revealed that they chose the less dominant face as the "really nice" face significantly more often than chance ($M$ = .443, $SD$ = .16), $t$(87) = -3.272, $p$ = .002, $d$ =-.349; 95% CI [-0.092, -0.023] (see Figure 4B). A subsequent ANOVA, with gender of the participant and gender of the stimulus faces as factors, revealed no significant effects of either participant gender, $F$(1, 86) = .021, $p$ = .885, $\eta^2$ < .001, or stimulus face gender, $F$(1, 86) = 3.213, $p$ = .077, $\eta^2$ = .019. These findings suggest that neither participant gender nor the gender of the faces influenced participants response. We also found no statistically significant age effects $F$(4, 83) = 1.16, $p$ = .334, $\eta^2$ = .053. Thus, when dominance cues are salient, boys and girls use the dominance cues to judge lower dominant faces as nicer, regardless of whether the pairs of faces were male or female.

*Do children use gender to judge niceness?* A One sample t-test of children's judgments in the Gender condition revealed that they chose the less dominant face as the "really nice" face significantly more often than chance ($M$ = .443, $SD$ = .16), $t$(87) = -3.272, $p$ = .002, $d$ =-.415; 95% CI [-0.092, -0.023] (see Figure 4B). A subsequent ANOVA, with gender of the participant and dominance level of the stimulus faces as factors, revealed no significant effect of stimulus dominance level, $F(1, 86) = .017$, $p = .898$, $\eta^2 < .001$. However, we did find a significant effect of participant gender, $F(1, 86) = 9.08$, $p = .003$, $\eta^2 = .056$, such that girls chose female faces more frequently than boys. We found no statistically significant age effects, $F(4, 83) = .741$, $p = .566$, $\eta^2 = .035$. Thus, when only gender cues were present, boys and girls across the age range tested chose the female face as nicer, with girls doing it more frequently than boys.

*Do children weight dominance over gender in judging niceness?* A One sample t-test of children's judgments in the Conflict condition revealed that they were at chance performance when choosing which face was "really nice" ($M$ = .53, $SD$ = .29), $t$(87) = .784, $p$ = .435, $d$ =.084; 95% CI [-0.038, 0.088] (see Figure 4B). An additional ANOVA, with gender of the participant revealed no significant effects, $F(1, 86) = .230$, $p = .632$, $\eta^2 = .003$. These findings suggest that participants' own gender did not influence their choices. We also found no statistically significant age effects $F(4, 83) = 1.35$, $p = .259$, $\eta^2 = .061$. Thus, when dominance and gender cues conflicted, children were unable to judge whether the male or female face is smarter, and children did not rely on their own gender to influence their choice.

Taken together, these results suggest that children use dominance to judge both intelligence and niceness in trait-specific fashion. That is, whereas more dominant faces were considered smarter by children, less dominant faces were considered nicer, with effects that were stable across gender of faces, across the age range tested, and participant gender only influencing choice of niceness in the Gender condition.

*Do other traits predict children's choices?* A concern with these findings is that although the faces were selected for their differences in dominance, they may have also varied in other traits that could have influenced children's judgments. To address this concern, we had $N$= 154 college age ($M_{Age}$=19.2) adult participants rate faces in similar fashion as Oosterhof & Todorov (2008) on a 9-point Likert scale (see brief explanation in Experiment 1) according to the following traits: attractiveness, dominance, competence, trustworthiness, meanness, frightening, extroverted, likeableness, and threatening. In a regression analyses to test whether any traits above and beyond dominance predicted children's choice, we found that none of the traits significantly contributed to children's choice: attractiveness (β = -0.019, $p$ = .815, 95% CI [-0.210, 0.172]), dominance (β = .140, $p$ = .600, 95% CI [-0.479, 0.760]), competence (β = -0.180, $p$ = .548, 95% CI [-0.873, 0.512]), trustworthiness (β = .139, $p$ = .579, 95% CI [-0.443, 0.722]), meanness (β = -0.042, $p$ = .823, 95% CI [-0.485, 0.400]), frightening (β = .136, $p$ = .792, 95% CI [-1.069, 1.340]), extroverted (β = .016, $p$ = .891, 95% CI [-0.255, 0.287]), likeableness (β = .095, $p$ = .718, 95% CI [-0.517, 0.707]), and threatening (β = -0.164, $p$ = .797, 95% CI [-1.656, 1.329]).

# Discussion

## Dominance cues are important when making inferences about individuals

Although previous research found that children discriminate faces based on dominance (Charlesworth et al., 2019; Oosterhof & Todorov, 2008), and both adults and children (by age 6) endorse the stereotype that males are smarter than females, it is unclear to what extent judgments of intelligence depend on differences in facial dominance. On average, males are more dominant in appearance than females (Oosterhof & Todorov, 2008) with males having a higher fWHR (Geniole et al., 2015), being larger in physical size (Lindenfors et al., 2007), and engaging in more dominant behavior (Dunbar & Burgon, 2005). We confirm this gender-dominance link with our findings from Experiment 1. In adults, we demonstrated that more dominant faces were perceived as more male. Given this link between dominance and gender, our finding that facial dominance plays a mediating role between gender and competence is consistent with our hypothesis as well. That is, males are not rated as smarter just because they are males, but perhaps because they are more dominant on average than females. Ratings of faces were specific to dominance, insomuch that dominance fully mediated the gender-competence link where adults rated higher dominant faces (also rated as more male) as more competent. This might be an indirect way of assessing a potential link between dominance and intelligence, but in the present study we show for the first time a direct link where dominance in faces is used for judgments of intelligence.

Notably, in a task with children we tested the strength of this dominance-intelligence link by pitting dominance against gender. As seen with children ages 6- to 10-years- old, (1) when male and female faces are matched in dominance, they are at chance for selecting either male or female faces, and (2) when dominance and gender is in conflict, children make their selections on the basis of dominance. Contrary to existing findings on the gender intelligence stereotype, children did not use gender to judge intelligence, but instead used dominance cues. Our findings suggest a dominance specific role, where dominance overrides gender in judging intelligence. Children judged more dominant female faces as smarter than less dominant male faces, not because of gender but because of dominance. Furthermore, our findings are consistent with dominance being important, insomuch that when children were shown two faces of the same gender, they made their selection solely on the basis of dominance and not because of other additional traits inherent in faces. Therefore, although previous research suggests that the gender stereotype is culturally transmissed, we believe that the gender stereotype might instead be rooted in dominance.

**Dominance and gender cues are important when judging a prosocial trait**

We tested to see if dominance cues would be used to make other inferences by looking at judgments concerning niceness. We found that children use dominance cues differentially based on the trait in question. Judgments of intelligence in children contrasted with this pro-social trait – niceness. Children's judgments were informed by both dominance and gender when judging which of two faces were nicer. Our findings indicate that when choosing between individuals of the same gender, children choose the lower dominant individual as nicer. Furthermore, when children did not have differences in dominance cues to base their decision on, they based their judgments on gender by choosing the female face as the nice individual compared to the male face. This finding is consistent with the gender-nice stereotype (Diekman & Eagly, 2000), where females are more often viewed as nicer and kinder than males. Our findings indicate that dominance cues play a role in making inferences beyond intelligence and could be used to explain other stereotypes as well.

Given the aforementioned findings, dominance appears to be privileged as a source of information in that it is being used separately for both intelligence and niceness but in opposite ways. Our findings show that the ‘stereotype’ of niceness is specific to gender earlier than intelligence, and not rooted solely in dominance. In other words, even when dominance is not available, children still regard females as nicer than males. Thus, our findings would suggest that dominance plays a key role when inferring intelligence and that dominance is more important than other cues such as gender when making judgments about intelligence. It also demonstrates that dominance is used as a source of information in that it serves to direct different choice outcomes.

**Why Specifically Dominance?**

Although in the above we mentioned that dominance cues are related to intelligence judgments and a prosocial trait in general, why might it be dominance specific? Perhaps a more general system for representing dominance, which can be used to predict success in different contexts, may also end up being used for judging intelligence.

We have previously briefly stated that more dominant individuals are more likely to be associated with a higher salary (Fruhen et al., 2015), access to resources (Enright et al., 2017), and reproductive success (Jack & Fedigna, 2006). Additionally, taller individuals are more likely to be rated as both more dominant and successful (Blaker et al., 2013) and males are also more likely to interrupt females while speaking (Hendrick & Stange, 1991). Furthermore, research also shows that success in the business world is associated with intelligence (Graham et al., 2017). Although it is true that the success in various contexts may be based on dominance as physical strength, it could also be used as a heuristic for intelligence. It can be reasoned that perhaps the dominant individuals are perceived to have additional knowledge that led them to acquire resources, a higher salary, or success. Given this potential link, we propose that our findings could be due to the exaptation of dominance and intelligence. Indeed, exaptation would lend support to this argument in helping explain why a trait might come to signal something other than what it was originally designed to (Gould & Vrba, 1982). It could be that dominance solely signaled physical strength and over time intelligence became coopted with dominance to help describe the correlation between dominance and success. However, this exaptation of dominance could also rely on optimal variations in dominance, where faces on the extreme side of high dominance could instead signal other information such as threat. Perhaps the relation between dominant and intelligence is a curvilinear relationship where only certain levels of dominance signals intelligence. However, we attempted to control for this potential effect by not using faces on the extreme high dominance side of the spectrum.

**Dominance acting as a perceptual signal**

Although previous work suggests that stereotypes are culturally transmitted (Martin et al., 2014), our findings are consistent with a perceptual signaling model whereby dominance signals intelligence (and a prosocial trait). Not only are participants able to distinguish between the perceptual features in faces (such as dominance cues), but they also use these perceptual dominance cues as signals to make inferences about different traits such as intelligence and niceness. Our participants identified the more dominant individual as intelligent across conditions, suggesting that dominance cues are more important than the culturally learned stereotype. If intelligence has been coopted with dominance, then it would make sense that individuals who appear more dominant (i.e. through facial features) would also be thought of as smart. Additionally, this perceptual signaling of dominance cues could be the mechanism through which exaptation of dominance and intelligence occurred and explain the implicit persistence of the gender stereotype (Charlesworth & Banaji, 2022).

Our findings have implications for other work on gender stereotypes as well. Previous research showing the gender-intelligence link did not control for perception or cues of dominance (Bian et al., 2017; Bian et al., 2018; Eagly et al., 2020; Oh et al., 2019). Perhaps these previous findings can instead be explained by a perceived difference in dominance. Our perceptual signaling model would suggest participants' responses are made based on dominance cues instead of gender given our findings that children did not rely on the gender stereotype in the absence of dominance differences. In other words, men are on average more dominant than females, and perhaps participants in these studies make their inferences on the basis of general knowledge about gender differences in dominance. An open question, however, is to what extent children and adults favor dominance equally? We didn't test the difference between adults and children directly but would hypothesize that adults might work harder to explicitly override implicit biases (Lagattuta & Kramer, 2017), whereas children would follow our perceptual signaling model.

Additionally, research showing faces are differentially judged based on racial appearance/identity also does not consider dominance (Chandrashekar, 2020; Xu et al., 2012). However, other research suggests that faces from different races are judged similarly on traits we collected (Sutherland et al., 2018) which could suggest similar effect for how dominance can signal intelligence across different races. Another question could be whether a context exists in which gender can override dominance. Perhaps when participants are explicitly asked to override dominance or engage in this tactic to appear favorable in the eye of the researcher, we would see that gender can be used instead of dominance. These are interesting questions to consider, but our study shows the existence of this coopting of dominance and intelligence within Caucasian faces and the overriding of gender by dominance.

Thus, it is critical to consider the influence of dominance when making judgments about intelligence. These dominance cues can subconsciously underpin the perpetuation of the gender stereotype more so than gender. Perhaps if we are expressly aware of the role of dominance through perceptual signaling, we can actively work to override this mechanism and combat the proclivity to use or endorse the gender stereotype.

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**Supplemental Materials:**

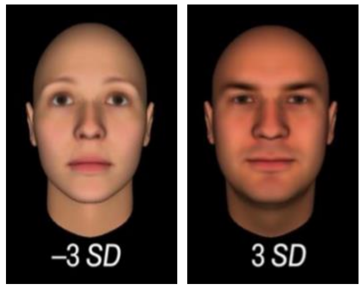


Figure 1. Examples of computer-generated faces in which the faces were manipulated (using FaceGen 3.1) on dominance features, such as length-to-width ratio, skin luminance, jaw shape, and eye shape. Standard Deviation (SD) reflects ratings of low (-3 SD) and high (3 SD) dominance.

Table 1

*Correlations between Dominance and all other collected trait ratings for faces presented to children in Study 2.*

| | | Dominance |
|---|---|---|
| Attractiveness | Pearson's r | 0.107 |
| | p-value | 0.064 |
| Competence | Pearson's r | 0.334*** |
| | p-value | < .001 |
| Trustworthiness | Pearson's r | -0.187** |
| | p-value | < .001 |
| Meanness | Pearson's r | 0.649*** |
| | p-value | < .001 |
| Frightening | Pearson's r | 0.391*** |
| | p-value | < .001 |
| Extroverted | Pearson's r | -0.024 |
| | p-value | 0.682 |
| Likable | Pearson's r | 0.074 |
| | p-value | 0.201 |
| Threatening | Pearson's r | 0.701*** |
| | p-value | < .001 |

*Note.* * $p < .05$, ** $p < .01$, *** $p < .001$