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Brandon F. Terrizzi, Elizabeth Brey, Kristin Shutts, and Jonathan S. Beier

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Children's Developing Judgments About the Physical Manifestations of Power

Brandon F. Terrizzi

Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio

Elizabeth Brey

University of Hawai'i at Mānoa

Kristin Shutts

University of Wisconsin-Madison

Jonathan S. Beier

University of Maryland, College Park

When navigating unfamiliar social environments, it is important to identify who is powerful. Determining who has power can be challenging because observers may have limited social information, and because people achieve influence for many reasons. In experiments with 3- to 5-year-old children ($n = 192$) and adults ($n = 32$), we investigated the developmental origins and conceptual structure of power judgments based on physical appearance. At 3 years of age, children already associated physical strength with expansive posture; soon after, expansive postures also supported judgments of normative authority and were joined by similar judgments about masculine facial structure. By the age of 4, children also matched high- and low-power versions of faces and postures together, indicating that they draw connections between different aspects of more or less powerful appearance. The complexity and timing of these changes highlights limitations in current accounts of the origins of adults' intuitions about powerful appearances. This study documents several novel developmental patterns that generate new hypotheses about the mechanisms that support the emergence of children's intuitions.

Keywords: face perception, nonverbal behavior, social dominance, social status, physical strength

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“Power” refers to a person's potential to control and influence others (Emerson, 1962; French, 1956; Magee & Galinsky, 2008). Aligning oneself with powerful people can be advantageous, earning physical protection and social privilege (Van Vugt & Grabo, 2015; Van Vugt, Hogan, & Kaiser, 2008). Furthermore, ignoring the desires of a powerful person can be dangerous—one risks physical reprisal, social sanction, or other negative consequences

(King, Johnson, & Van Vugt, 2009; Van Vugt, 2006). To ensure adaptive outcomes, people must recognize who is powerful, anticipate what powerful people want, and respond strategically to their behavior (Anderson & Brown, 2010; Anderson & Kilduff, 2009; Halevy, Chou, & Galinsky, 2011; Magee & Galinsky, 2008; Sapolsky, 2005).

Navigating real-world power dynamics is far from straightforward (Bierstedt, 1950; Flack & de Waal, 2007; Freeman & Ambady, 2011). Consider the challenges of one's first day in a workplace, on the prison yard, or at a new school. Who holds power? When entering new social contexts, information that clearly reveals the relative power of specific individuals may be sparse. Diagnostic third-party interactions (e.g., seeing one person tell another what to do; Charafeddine et al., 2015; Smith & Hofmann, 2016) may not occur; controlled resources (a privilege of the powerful; Enright, Gweon, & Sommerville, 2017; von Rueden, Gurven, & Kaplan, 2008, 2011) may be kept out of sight; and conventional signifiers (e.g., special clothing; Gurney, Howlett, Pine, Tracey, & Moggridge, 2017) may require local cultural knowledge to appreciate their meaning. Given these constraints, observers should be highly motivated to seek evidence about power from information that is more reliably available. One such source of information is a person's physical appearance, which can signal the presence of both person-specific capabilities like physical strength and more subjective attributes like confidence (Anderson, Brion, Moore, & Ken-

Brandon F. Terrizzi, Division of General and Community Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio; Elizabeth Brey, Department of Psychology, University of Hawai'i at Mānoa; Kristin Shutts, Department of Psychology, University of Wisconsin-Madison; Jonathan S. Beier, Department of Psychology, University of Maryland, College Park.

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Correspondence concerning this article should be addressed to Brandon F. Terrizzi, Division of General and Community Pediatrics, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, Cincinnati, OH 45229. E-mail: brandon.terrizzi@cchmc.org

nedly, 2012; Freeman & Ambady, 2011; Little, Burriss, Jones, & Roberts, 2007; Lukaszewski, Simmons, Anderson, & Roney, 2016; Sell, Hone, & Pound, 2012).

An additional challenge of navigating power dynamics is that people derive power from many sources.¹ Those with superior physical capabilities, such as brute strength, may assert control through physical force or intimidation (Mazur, 1985; Murray & Schmitz, 2011; Sell et al., 2010, 2012). Others may hold powerful social roles, such as being a boss, that grant a more normative basis for their authority (Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013; Halevy, Chou, Cohen, & Livingston, 2012; Henrich & Gil-White, 2001). The relation between physical strength and normative authority is complex: Some individuals possess one but not the other, while others may draw power from both sources. Recognizing the basis of a person's power and its relevance to a particular context is critical for making decisions about how to best monitor and respond to them (Arnott & Elwood, 2009; Chudek, Heller, Birch, & Henrich, 2011; Henrich & Gil-White, 2001; Parker, 1974; Pietraszewski & Shaw, 2015; Smith & Price, 1973). For instance, during brief, anonymous, private interactions (e.g., a lone encounter in a dark alley), there may be little cost to flouting the wishes of an authority figure, unless that figure is also physically formidable. Likewise, in public, normatively structured environments (e.g., a boardroom), disobeying an authority's commandments may be a poor choice, regardless of the authority's level of personal strength.

Here we examine children's developing abilities to meet both of the challenges identified above: determining who is powerful from limited social information like physical appearance and appreciating that power can be based on both physical formidability and normative social roles. As reviewed below, much remains unknown about how children conceive of the interrelations between different perceptual cues to power and their various interpretations, as well as the developmental mechanisms that support the emergence of these links. The aim of the present research is to investigate the developmental trajectory of this conceptual structure, to better understand children's intuitions about powerful appearances. Doing so will help constrain theorizing about the basis for our intuitions about the physical manifestations of power, as such theories must account for the conceptual associations and dissociations that may arise.

We focus on children's developing judgments regarding two appearance-based cues (i.e., facial structure and body posture) and two specific forms of power (i.e., physical strength and normative authority). Both facial structure and body posture meet the criterion for reliable power cues outlined above: They are typically available to observers across multiple contexts (e.g., their manifestation does not depend upon the presence of third parties, and they can often be viewed from afar). Importantly, as discussed below, both of these cues have been linked to adults' power attributions. Similarly, we targeted children's notions of strength and authority because these characteristics are most directly related to our working definition of power: the potential to exert control over others. Although children reason about other personal characteristics associated with hierarchy, status, and leadership, not all of these characteristics fit the core of our definition (e.g., prestige is more closely related to selective trust and epistemic authority; Chudek et al., 2011).

Adults' Attributions of Power

When adults encounter new people, they infer power from multiple aspects of appearance. They view people with a more mature, masculine facial structure (e.g., a pronounced brow or jawline) as both physically stronger (Holzleitner & Perrett, 2016; Toscano, Schubert, Dotsch, Falvello, & Todorov, 2016; Toscano, Schubert, & Sell, 2014) and more socially dominant (Lukaszewski et al., 2016; Oosterhof & Todorov, 2008; Toscano et al., 2016). Adults also recognize that body posture both reflects a person's current feelings of power (Shariff & Tracy, 2009; Tracy, Robins, & Lagattuta, 2005) and that people may communicate their assumed status to others through expansive poses (Brey & Shutts, 2015; Burgoon, Buller, Hale, & Turck, 1984; Holland, Wolf, Looser, & Cuddy, 2017; Koski, Xie, & Olson, 2015).

Although adults understand that physical strength and authority are different things, their attributions reveal similar thinking about the physical manifestation of these two forms of power. For example, faces that adults describe as socially dominant are similar to those they describe as physically strong (Toscano et al., 2016). Further, although no research has examined whether expansive postures make bodies appear stronger, there is evidence for links among related representations: Adults' judgments of social dominance from expansive posture are mediated by perceptions of overall size (Marsh, Yu, Schechter, & Blair, 2009), and size estimations can covary with judgments of physical strength (Fessler, Holbrook, & Snyder, 2012; Mattan, Kubota, & Cloutier, 2017; Murray & Schmitz, 2011; Yu, Sun, Zhou, Xu, & Shen, 2017). Moreover, adults sometimes view people with a muscular physique as both strong and likely to hold authority and influence over others (Lukaszewski et al., 2016).

In summary, there is considerable overlap between the concepts of strength and authority evoked by certain facial structures and body postures. Moreover, individual appearance-to-power associations are not represented in isolation from one another. Rather, these associations are units within a complex conceptual structure that draws connections both between and among different aspects of appearance and different forms of power. Ultimately, developmental theories regarding our intuitions about powerful appearance must explain how this interwoven conceptual organization comes to be.

Developmental Origins of Power Attributions

Already by the preschool years, young children reason about power in a number of ways. They identify the more powerful of two characters by using a wide range of cues presented in acted displays and verbal descriptions of agents in third-party interactions (Bernard et al., 2016; Brey & Shutts, 2015; Charafeddine et al., 2015, 2016; Gülgöz & Gelman, 2017; Over & Carpenter, 2015;

¹ Research on this topic often uses the term "dominance" to describe a characteristic much like how we have defined "power." Both terms refer to the ability to control others. However, some research traditions emphasize that dominance boils down to physical control and intimidation (Henrich & Gil-White, 2001), whereas others maintain that both physical formidability and normative authority contribute to an individual's dominance level (Lukaszewski et al., 2016; Murray, 2014; Murray & Schmitz, 2011). Because we recognize that formidability and authority are independent routes to control (Cheng et al., 2013), we use the term power here.

Pietraszewski & Shaw, 2015; Zhao & Kushnir, 2018). Children's judgments in these studies affirm that, like adults, they associate power with interpersonal control. They view powerful characters as those who prevail in physical contests (Bernard et al., 2016; Pietraszewski & Shaw, 2015) and who establish how others ought to behave in their presence (Gülgöz & Gelman, 2017; Over & Carpenter, 2015; Zhao & Kushnir, 2018).

Preschool-age children also reason about relative authority and physical strength in particular. Even 3-year-old children label someone as "in charge" when they have observed or heard descriptions of that person telling another person what to do, making rules, or having decision-making power over others (Bernard et al., 2016; Brey & Shutts, 2015; Charafeddine et al., 2015; Gülgöz & Gelman, 2017). At these same early ages, witnessing two individuals' relative lifting capacities informs children's predictions of who will be able to lift a heavy object in the future (Fusaro, Corriveau, & Harris, 2011) and their personal preferences for a collaborative partner on physical tasks (Hermes, Behne, Bich, Thielert, & Rakoczy, 2018; Hermes, Behne, & Rakoczy, 2015; Hermes et al., 2016). Further, at 3.5 years, children endorse someone described as physically stronger as the recommended helper for a task requiring strength (Paulus & Moore, 2011). Thus, although young children's understanding of strength and authority likely continues to develop, their understanding of these distinct sources of power resemble adults' concepts in important respects.

Recent research has also examined young children's attributions of power from different aspects of physical appearance. Most notably, preschoolers reason that a person with mature, masculine facial features is "stronger" than someone who lacks these features (Cogsdill, Todorov, Spelke, & Banaji, 2014) and that a person with broad, expansive posture is in charge relative to someone exhibiting diminutive, restrictive posture (Brey & Shutts, 2015; Charafeddine et al., 2015). Additionally, as reported in the supplemental material, 3-year-old children also identify people with larger musculature as stronger than those with smaller musculature. These attributions reveal that, also like adults, children see correspondences between certain aspects of physical appearance and different forms of power.

Although the above research provides an important foundation, it is not yet sufficient for building theories about the developmental processes that give rise to adults' intuitions about powerful appearances. Because these studies have focused on children's attributions from only a single appearance-based cue, or about a single notion of power, they do not address the full complexity of the conceptual structure underlying adults' judgments. Consequently, it is unclear how and when children acquire their initial representations of powerful appearances and what notions of power children can or cannot infer from different cues.

The present study was designed to address three outstanding questions. First, when do children first become sensitive to the individual aspects of appearance that adults view as powerful? Cogsdill and colleagues (2014) observed sensitivity to power-relevant variation in facial structure in a collection of 3- and 4-year-old children, but did not report analyses exploring developmental changes during this period. A more recent study with even younger children found that 7-month-olds do not visually prefer either dominant or subordinate faces (Jessen & Grossmann, 2016); however, sensitivity to such appearances may exist without preferring one over the other. This uncertainty about when children

first become sensitive to these aspects of facial structure highlights the need to conduct more thorough investigations in early childhood.

Similar ambiguities arise regarding children's sensitivity to body posture. The only study assessing power attributions from isolated postural information found that children do not use postural expansiveness to judge the relative authority of two people until 5 to 6 years of age (Brey & Shutts, 2015). Other studies provide hints of such abilities at younger ages, but their results are inconclusive. For instance, 4-year-old children and adults label displays combining expansive posture and a smiling expression as prideful (Tracy et al., 2005), and adults also attribute high status from the same displays (Shariff & Tracy, 2009; Tracy & Robins, 2004). However, the relative contributions of postural and facial cues to children's attributions is unknown (Tracy et al., 2005); moreover, there is no evidence that children also link pride with power, and one study finds that preschoolers view these displays as more indicative of anger than pride (Nelson & Russell, 2012). Similarly, in another study, 3-year-olds attributed authority in a manner consistent with the relative postural expansiveness of characters, but the stimuli also included other pragmatic cues, such as one character's imperative pointing gesture toward the other (Charafeddine et al., 2015). Thus, more research is needed to isolate the conditions under which children younger than 5 are sensitive to power-relevant variation in body posture.

Second, do children draw connections between different aspects of appearance that provide information about a person's power? By analogy, infants see correspondences between emotions expressed in faces and postures (Grossmann, 2010; Hock et al., 2017), and facial and postural information jointly contribute to adults' inferences about a person's emotional state (de Gelder, de Borst, & Watson, 2015; Hassin, Aviezer, & Bentin, 2013). These findings indicate that infants and adults possess distinct representations of emotional faces and bodies, and that these representations exist within a larger conceptual framework that allows observers to draw connections between them. Similar associations may occur for power-related representations, yet no studies have assessed whether children or adults link powerful faces and bodies.

Third, what range of power concepts do children associate with different aspects of a person's appearance? Previous investigations of children's judgments from visual appearance have only assessed their attributions of a single notion of power from a single aspect of appearance (i.e., just strength from facial structure; just authority from posture). Given the interrelations among different appearance-based cues and notions of power in adults' judgments, children may be developing (or already possess) more integrated intuitions about powerful appearances than previous approaches have revealed. Knowing the range of meanings that children ascribe to different cues is an essential step in describing the conceptual framework underlying their understanding of powerful appearances. For instance, if children attribute different types of power to faces and postures, it would suggest that distinct developmental mechanisms may underlie the acquisition of face-power and posture-power associations.

The Present Research

To investigate these issues, we examined both adults' and children's intuitions about how different notions of power (i.e.,

strength and being in charge) describe variation in facial structure and body posture. Experiment 1, conducted with adult participants, served multiple purposes. The main goal was to characterize the full pattern of adults' judgments before investigating the same patterns in children. Although prior work has assessed adults' intuitions about a subset of these cue and attribution combinations, one combination was novel (i.e., physical strength from postures). Additionally, as no research to our knowledge has asked about all combinations together, the present study illuminates the relative strengths of these inferences.

Experiments 2 and 3 took two different approaches to assessing children's intuitions about the physical manifestation of power. First, in a task that closely resembled the one that adults completed, we asked children to produce judgments about physical strength and normative authority from variation in faces and postures. Second, we designed a task to assess the extent to which children view powerful faces and bodies as "going together." We conducted these studies with children from 3 through 5 years of age, as previous research has revealed developmental changes in children's sensitivities to power-relevant variation in faces and postures during this period (Brey & Shutts, 2015; Charafeddine et al., 2015; Cogsdill et al., 2014).

Experiment 1

Experiment 1 assessed the separate influences of facial structure and body posture on adults' attributions of strength and authority.

Method

Participants. Thirty-two adult undergraduate students with normal or corrected-to-normal vision (16 women; $M_{\text{age}} = 20.04$ years, $SD = 1.57$ years) participated online for course credit. Four additional students who did not complete the study were excluded.

Materials. Participants viewed paired images of two people, side-by-side and facing forward (i.e., not interacting with one another). Half of these displays showed two faces differing in their

inherent structure (bodies not visible). The other half showed two bodies differing in their postural expressions (faces not visible). Figure 1 shows example displays and the entire stimulus set is available at OSF (Terrizzi & Beier, 2018; <https://osf.io/zghyf/>). Characters were aligned so that neither seemed taller than the other. All faces occupied a 600×400 pixel region of the display. High and low power bodies occupied 730×490 and 730×270 pixel regions, respectively.

Face stimuli were created with FaceGen v3.1 and drawn from a larger database of 175 male, computer-generated faces (Oosterhof & Todorov, 2008). Each face was derived from a computational model capturing the aspects of facial structure that covary with adults' judgments of a face's "dominance." Faces high in dominance have mature, masculine features (e.g., pronounced brow and jawline) while faces low in dominance have less mature, less masculine features. Adults' impressions of these faces have been extensively validated in many studies of dominance perception (Cogsdill et al., 2014; Oosterhof & Todorov, 2008; Toscano et al., 2014, 2016).

Body stimuli were drawn from a larger set of 132 male, computer-generated characters created by the authors using Poser Version 10. The body pose of each character was manipulated based on prior research demonstrating that adults view people holding expansive postures as powerful and restrictive postures as less powerful (Brey & Shutts, 2015; Burgoon, Johnson, & Koch, 1998; Holland et al., 2017).

We planned to compare participants' inferences across faces and bodies, as well as to compare attributions of strength and authority within each stimulus type. Thus, we conducted an initial norming study to ensure that adults' perceptions of dominance for the final set of stimuli were matched, both across and within faces and bodies (see Figure 1 and the supplemental material for details; no adults who participated in the norming study participated in Experiment 1). Figure 2 shows that the final stimulus set had excellent properties.

Procedure and design. The procedures of this and all subsequent experiments were approved by the Institutional Review

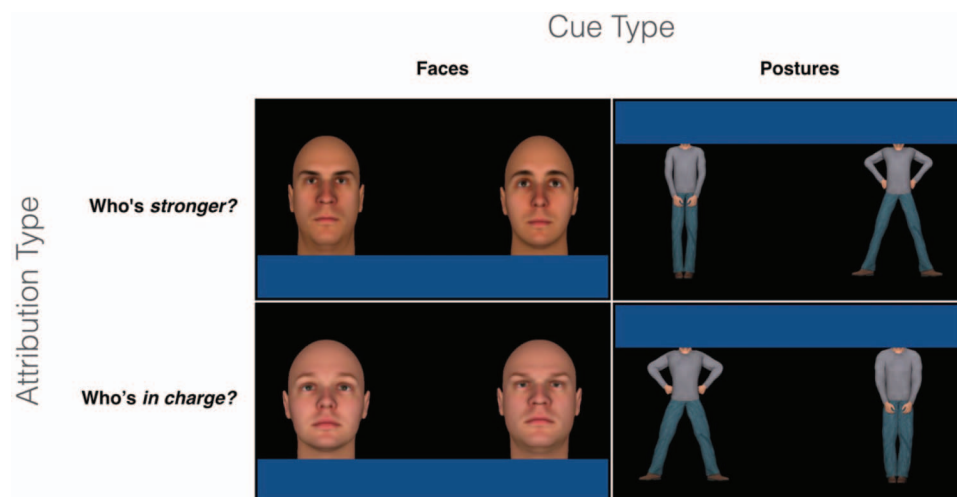


Figure 1. Examples of each test trial type from the attribution task of Experiments 1 and 2. Face images were created by Oosterhof and Todorov (2008). Body images were created by the authors. See the online article for the color version of this figure.

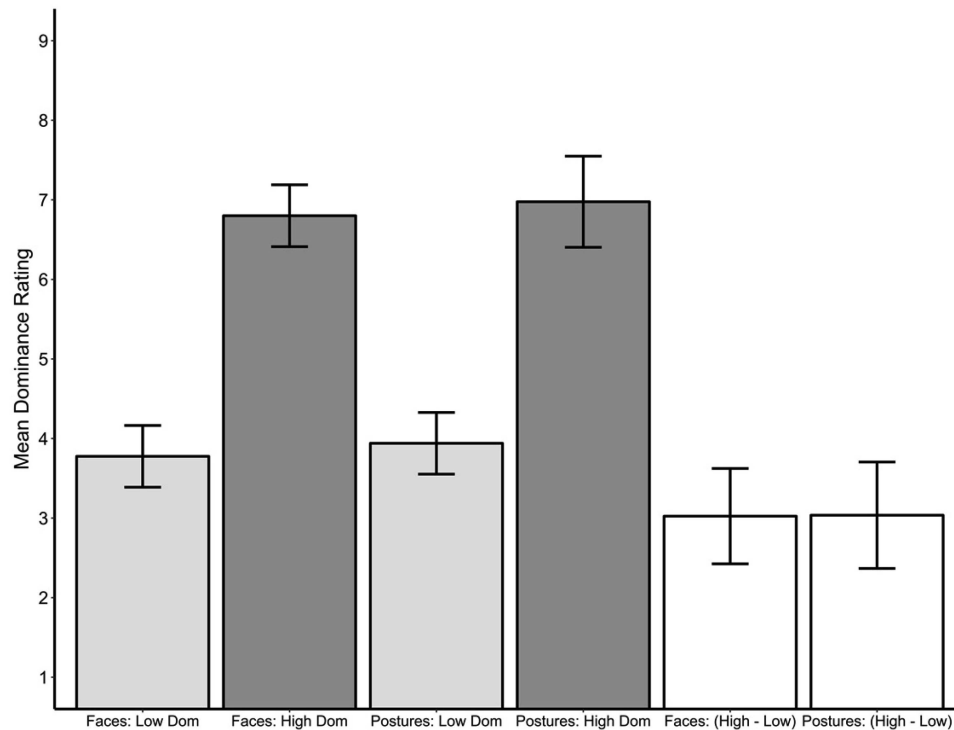


Figure 2. Mean dominance and difference scores (High—Low) for the final selection of high and low power faces and postures from Experiment 1's norming study. Error bars are 95% confidence interval.

Board of The University of Maryland (Titles: Cognitive and Social Processes in Adults/Children and How Children Form First Impressions of Other People; Protocol numbers 357272–12/410239–11 and 996211–3). On each of 20 trials, participants indicated whether the more powerful character was on the left or right. Trials proceeded in four blocks (five trials each). Each block presented the same cue (i.e., faces or postures) and requested the same attribution (i.e., strength or authority) across trials, reflecting a 2×2 within-subject design. Before each block, we instructed participants to select the person they thought was stronger or in charge, and we provided a clear definition of these terms: “A person who is strong is someone who can lift and move really heavy things” or “A person who is in charge gets to make all the rules and gets to tell others what to do.”

The initial cue and attribution types were counterbalanced across participants. Whereas cue type alternated between blocks, the attribution type was the same for the first two blocks and then switched. To assign stimuli to blocks, the 10 face and 10 body pairs were divided into two sets (five face and five body pairs each), whose presentation order was counterbalanced across participants. Within blocks, the presentation order of images was determined by a random number generator and fixed for all participants. Across both cues and attributions, the more powerful character appeared with equal frequency on the left and right.

Coding and scoring. All analyzed participants responded on all trials. These responses were coded for consistency with the answers suggested by our prior norming study (i.e., selecting the person with a mature, masculine face or the person exhibiting

broad, expansive posture as the more powerful character). For each of the four blocks, scores were also calculated reflecting the proportion of trials in which the anticipated response was given.

Statistical approach. For this and all subsequent experiments, data analyses were conducted using R version 3.4.4. For each experiment, we first conducted preliminary analyses assessing whether participants' responses were influenced by each study's counterbalancing factors. In particular, we were interested in discovering whether participants' judgments were meaningfully influenced by the order in which they saw either cue type or the order in which they made different attributions. Because these analyses did not reveal any significant main effects or easily interpretable interactions in any of our experiments, these factors were omitted from further analyses.

For the main analysis, we used a Generalized Linear Mixed Model (GLMM) fit by maximum likelihood with Laplace approximation and a binomial link function to determine the fixed effects and interactions of Attribution Type and Cue Type on participants' dichotomous (anticipated or unanticipated) judgments on each trial. This model was built using the *glmer()* function of the *lme4* package (Bates, Maechler, Bolker, & Walker, 2015). This approach accounts for the correlated nature of responses across trials; our model included a random intercept term identifying individual subjects. Whereas the GLMM analyzed participants' judgments on each trial, our follow-up analyses examined the proportions of participants' “correct” responses across ages and trial types. To avoid distributional assumptions, these additional planned analyses were pursued with two-tailed nonparametric tests: one-sample Wilcoxon's tests for comparisons to chance (chance = .50) and

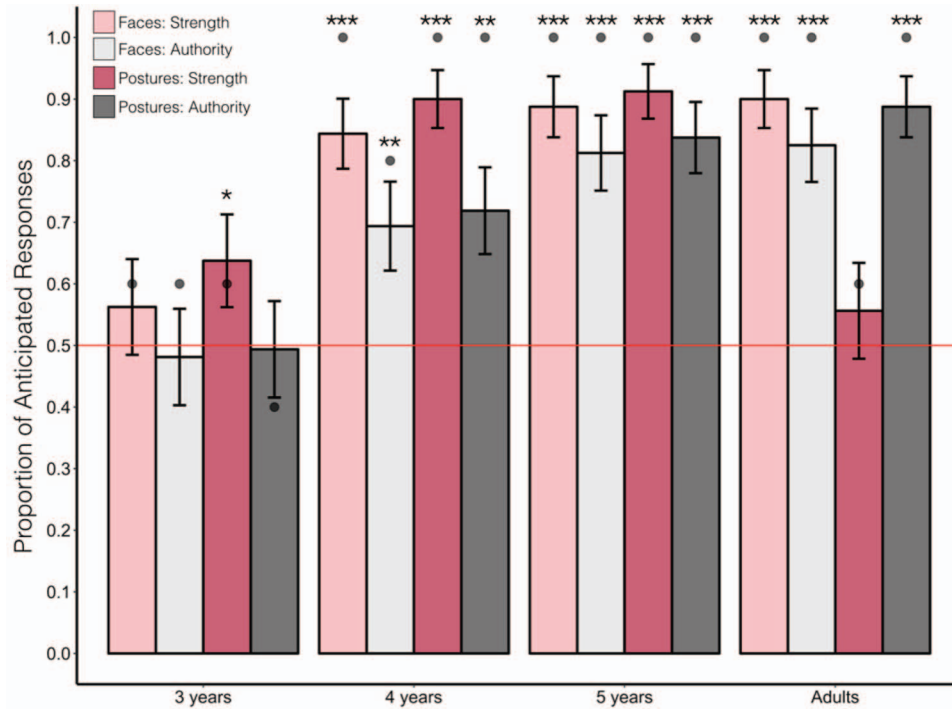


Figure 3. Mean (bars) and median (dots) proportion of trials in which participants selected high power faces and bodies for each trial type in Experiment 1's and Experiment 2's attribution task. Asterisks indicate significant deviations from chance (0.50). Error bars are 95% confidence interval. * $p < .05$. ** $p < .01$. *** $p < .001$. See the online article for the color version of this figure.

both paired Wilcoxon's and unpaired Mann–Whitney tests, as appropriate.

Results

Figure 3 and Table 1 present the proportion of responses in the anticipated direction for each combination of attribution and cue type. There were main effects of both Attribution Type, $\chi^2(1) = 12.46$, $p < .001$, and Cue Type, $\chi^2(1) = 14.04$, $p < .001$, as well as a significant interaction between these factors, $\chi^2(1) = 36.24$, $p < .001$. Participants attributed both strength and authority (i.e., being in charge) from facial structure in the predicted manner, but they only attributed authority from body posture. Their judgments about relative strength from differences in body posture were less consistent than judgments about relative strength from facial structure, $z = 4.30$, $p < .001$, relative authority from body posture, $z = 4.06$, $p < .001$, and relative authority from facial structure, $z = 2.70$, $p = .007$.

Discussion

Our findings converge with those from previous demonstrations of adults' attributions from faces. The same mature, masculine facial features that give rise to impressions of physical strength also support impressions of authority (Toscano et al., 2016). Adults' attributions from faces suggest that they see some connections between these distinct notions of power. However, participants' impressions of people differing in their outward postural expressions also provide novel insight into the limits of these links,

shown here for the first time: Adults saw people with broad, expansive posture as holding more authority, but did not consistently view these same people as stronger. The results from Experiment 1 provide a baseline for evaluating the development of children's intuitions about the power of those whom they encounter.

Experiment 2

Experiment 2 investigated developments in 3- to 5-year-old children's representations of powerful appearances in two different ways. First, children produced judgments about the relative power of different characters, in a child-friendly version of the task that adults performed in Experiment 1 ("attribution task"). Next, the same children completed a task probing whether they thought powerful faces and bodies "go together" ("matching task").

Previous work has demonstrated that even 3-year-old children (the youngest age we tested) understand the term "in charge" and can indicate which of two characters holds more authority (Brey & Shutts, 2015; Charafeddine et al., 2015; Gülgöz & Gelman, 2017). Although other research indicates that 3-year-olds reason accurately about a person's physical strength (e.g., Hermes et al., 2016), their ability to deploy this understanding in a format like the present attribution task has not been well established. Thus, in a separate experiment we first confirmed that 3-year-old children indicate—with very high consistency—that people with greater musculature are stronger than people with lesser musculature (reported fully in the supplemental material; see Figure 5 for example stimuli). This finding indicates that 3-year-olds hold at

Table 1
Results From Experiments 1 and 2

Age group	Trial type	Attribution task					Task correlations	
		<i>M</i>	<i>SD</i>	<i>Mdn</i>	<i>z</i>	<i>p</i>	ρ	<i>df</i>
3-year-olds	Faces - strength	.56	.50	.60	.66	.224	.28	30
	Faces - authority	.48	.50	.60	.35	.877	.03	30
	Postures - strength	.64	.48	.60	1.67	.030	.11	30
	Postures - authority	.49	.50	.40	.49	.995	.22	30
4-year-olds	Faces - strength	.84	.36	1.00	5.01	<.001	.54***	30
	Faces - authority	.69	.46	.80	2.38	.004	.13	30
	Postures - strength	.90	.30	1.00	5.24	<.001	.30	30
	Postures - authority	.72	.45	1.00	2.28	.005	.22	30
5-year-olds	Faces - strength	.89	.32	1.00	4.71	<.001	.40*	30
	Faces - authority	.81	.40	1.00	3.62	<.001	.61***	30
	Postures - strength	.91	.28	1.00	5.12	<.001	.25	30
	Postures - authority	.84	.37	1.00	3.81	<.001	.44**	30
Adults	Faces - strength	.90	.30	1.00	5.15	<.001		
	Faces - authority	.83	.38	1.00	3.94	<.001		
	Postures - strength	.56	.50	.60	.49	.325		
	Postures - authority	.89	.32	1.00	4.78	<.001		

Note. Mean and median proportion of trials on which participants responded in the anticipated manner, on each trial type of the attribution task, followed by one-sample Wilcoxon tests comparing the median response to chance (.50). The rightmost columns display nonparametric Spearman's correlations between the proportion of anticipated responses on the matching task and each trial type of the attribution task.

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

least one accurate intuition about strong appearances (as musculature and strength actually covary). Moreover, 3-year-olds are clearly capable of attributing strength to individuals on the basis of their physical appearance, as is required of them in the present attribution task.

Method

Participants. Ninety-six 3- to 5-year-old children, divided equally across three age groups, participated in the study (3-year-olds: $M_{\text{age}} = 3.57$ years, $SD = .31$; 4-year-olds: $M_{\text{age}} = 4.55$ years, $SD = .27$; and 5-year-olds: $M_{\text{age}} = 5.50$ years, $SD = .29$). Each age group contained an equal number of boys and girls. Children were typically developing, exposed predominately to English ($\geq 70\%$), and were recruited from a database of families in the greater Washington, DC area who expressed interest in participating in developmental studies. Caregivers identified their children as primarily White (62.1%), Black/African American (15.8%), or Asian (11.6%). The remaining children were identified as either Native American, Hispanic, or "Other." The modal annual income of participating families was over \$100,000. Children participated individually in a university research lab and received a small toy for attending.

Eight additional children were tested but excluded from analyses because they either failed to complete every trial of the attribution task (four 3-year-olds and one 4-year-old), or because of a technical error that disrupted video recording (one 4-year-old and two 5-year-olds).

Materials and procedure.

Attribution task. All children completed the attribution task first. Display images were identical to those used in Experiment 1. Each child viewed the displays on a 23" monitor ($1,920 \times 1,080$ pixels) at a distance of approximately 55 cm. The monitor was on a child-sized table. The experimenter sat slightly behind and to the left of the child; the experimenter was, therefore, out of the child's

line of sight during test trials. The experimenter controlled the experimental display from a wireless mouse operated in their lap.

The task began with a brief practice session (three trials) to accustom children to the experimenter's verbal instructions. On each practice trial, children saw two circles (one yellow, one purple) and were asked to point to the purple circle. All children responded perfectly.

Next, the experimenter explained that they would now view images of people. Children were told to look at each person carefully and then point to the person who was either stronger or in charge. Only one term was used for each block. Children heard the same definitions of these terms used in Experiment 1. All children confirmed comprehending each definition the first time it was provided. The experimenter repeated the relevant definition before each block.

On each trial, a fixation cross was visible while the experimenter provided instructions, "Look at both people carefully, and point to the person who's stronger/in charge." The experiment made sure that the child was looking at the fixation cross before revealing the test display and did not provide feedback on the child's selections.

Matching task. Children were encouraged to place images of individual faces and bodies together. The face and body images were the same stimuli used in the attribution task. The body images were presented in a flipbook with a single body on each page. Laminated cut-outs of individual faces could be affixed to the bodies by joining small strips of Velcro, one located on the back of each face and the other above the shoulders of each body. The experimenter sat directly across from the child to administer the task.

The experimenter told the child a brief story—that the new game had a book with pictures of both faces and bodies but, earlier, all the faces fell off. The experimenter explained that they needed the child's help putting the faces where they belong. Each trial began with the flipbook open to two blank pages. Next, the

experimenter handed the child two face cut-outs, stacked one on top of the other. For consistency, the more dominant face was always on top, and the experimenter prompted the child to look at both faces carefully. After the child had examined both images, the experimenter asked the child to place the faces side-by-side on the table (in whatever order the child wished), so that both could be seen simultaneously. The experimenter then turned the page to reveal two headless bodies, one on each opposing page, and prompted the child to place the images “where they belong.” The experimenter did not provide feedback on children’s choices and did not make any suggestions for how faces and bodies could be aligned.

Design.

Attribution task. For each child age group, the experimental design was identical to the design used in Experiment 1. Children participated in four 5-trial blocks, with each block focused on a single Attribution (i.e., strength, in charge) and Cue (i.e., face, body) type.

Matching task. The matching task consisted of 10 trials. On each trial, children saw the high and low power versions of a single face and body pair. The presentation order of the face and body pairs on each trial was determined by a random number generator and fixed for all participants. The body with expansive posture appeared with equal frequency on the left and right, in an ABBABBAABA fashion. Children were randomly assigned to one of two conditions that varied whether A referred to the left or right.

Coding and scoring.

Attribution task. On each trial, children responded by pointing to the character they thought was more powerful. As with Experiment 1, children’s responses were coded for consistency with the direction expected by the “dominance” ratings of Experiment 1’s norming study. For each of the four blocks, scores were calculated reflecting the proportion of trials in which the anticipated response was given.

Matching task. On each trial, children affixed two cut-out images of faces to two images of bodies in a flipbook. Children’s responses were coded from a video recording of the flipbook taken after the study was concluded. Choices on each trial were coded for consistency with the direction expected by the dominance ratings of Experiment 1’s norming study. For each trial, scores reflected the proportion of trials in which the anticipated response was given.

Two independent coders (the first author and a research assistant uninvolved in data collection) recorded the responses of all participants on each trial of both tasks from video recordings of each session. Their initial agreement was almost perfect (Attribution $\kappa = .98$; Matching $\kappa = .98$), and all discrepancies were resolved through discussion.

Statistical approach. Our approach to analyzing children’s responses was similar to the approach we used to analyze adults’ responses in Experiment 1. In the attribution task, we assessed responses using a GLMM as before, with the addition of a fixed effect of Age Group factor (and interactions between it and Attribution and Cue Type, as well as their three-way interaction). In the matching task, we assessed the effect of Age Group on participants’ dichotomous (anticipated or unanticipated) matching decisions across trials. Because both models now featured Age Group as a between-subjects fixed effect, follow-up analyses also included Bonferroni-corrected Dunn’s tests for multiple comparisons across age groups.

Results

Attribution task. Figure 3 presents the proportion of responses in the anticipated direction for each combination of Attribution and Cue Type for each age group. In our main analysis, there were main effects of Attribution Type, $\chi^2(1) = 44.15, p < .001$, Cue Type, $\chi^2(1) = 4.68, p = .031$, and Age Group, $\chi^2(2) = 31.87, p < .001$, and a significant interaction between Attribution Type and Age Group, $\chi^2(2) = 7.33, p = .026$. Children selected the anticipated character most consistently when attributing strength and when making judgments from variation in body posture. Overall, 3-year-olds were less consistent in their judgments than 4- and 5-year-olds, $z_s = 3.82$ and 5.24 , respectively, $ps < .001$, but 4- and 5-year-olds did not significantly differ from each other, $z = 1.42, p = .235$.

To further understand the complete pattern of children’s judgments, and to pursue the interaction of Age Group and Attribution Type, we assessed the responses of children in each age group using a GLMM to determine the fixed effects and interactions of Attribution Type and Cue Type on participants’ dichotomous judgments on each trial. Children had stronger intuitions about strength than authority at each age, but the effect was largest at 4 years: 3-year-olds: $\chi^2(1) = 9.62, p = .001$; 4-year-olds: $\chi^2(1) = 32.17, p < .001$; 5-year-olds: $\chi^2(1) = 10.01, p < .001$. Analyzing each age group separately, there were no significant effects of Cue Type (all $ps > .14$) nor interaction between factors (all $ps > .36$).

Table 1 shows planned nonparametric comparisons of children’s anticipated responses on each trial type to chance (chance = 0.50). Three-year-old children did not often respond in the predicted manner. There was only one trial type on which they performed above chance: attributing strength based on posture. In contrast, both 4- and 5-year-old children responded above chance on all four trial types, attributing both strength and authority to more masculine faces and expansive postures. The supplemental material contains planned analyses comparing responses on each trial type across ages.

Figure S2 in the supplemental material indicates there was no cluster of children at any age whose most prominent response was to select less masculine faces or more restrictive postures as either strong or in charge. This indicates that children do not typically pass through a developmental stage at which they are sensitive to power-relevant variation in facial structure or body posture but map that variation to appearance in a direction opposite their later intuitions.

At the suggestion of an anonymous reviewer, we also examined how our results varied across the duration of the experiment. Figure S3 in the supplemental material presents scores for each trial type at each age, grouped according to the block in which children viewed that trial type. Because of the exploratory nature of these analyses, their small sample sizes, and many uncorrected tests, caution is warranted in interpreting these patterns. However, it does appear that 3-year-olds attributed strength to dominant faces when this trial type appeared in either the first or second block. As a comparison, 3-year-old children attributed strength from expansive posture in the first three (of four total) blocks. Thus, this exploratory view of the data supports our main conclusion that children have stronger intuitions about power-relevant variation in postures compared to facial structure, if not the claim that children are sensitive to postures first.

Matching task. Figure 4 displays children’s performance on the matching task. Our main analysis indicated a significant effect of Age Group, $\chi^2(2) = 34.66, p < .001$. Three-year-old children performed

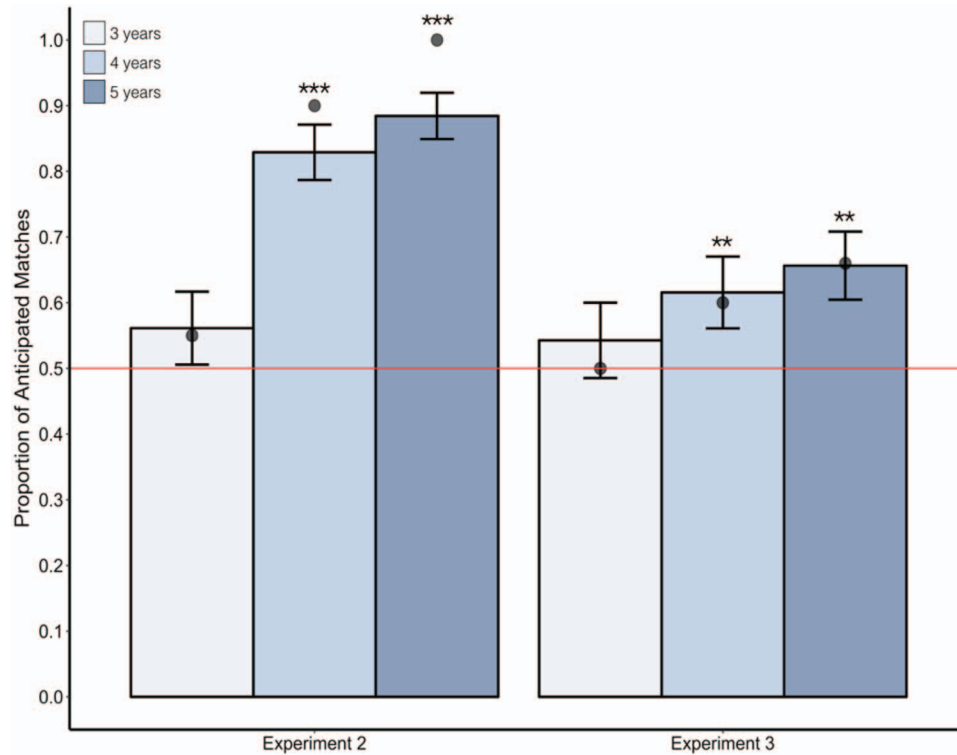


Figure 4. Mean (bars) and median (dots) proportion of trials in which children matched powerful faces and bodies together. Asterisks indicate significant deviations from chance (0.50). Error bars are 95% confidence interval. ** $p < .01$. *** $p < .001$. See the online article for the color version of this figure.

significantly worse than both 4- and 5-year-olds, $z_s = 4.37$ and 5.39 , respectively, $ps < .001$, whereas the two older groups did not differ from each other, $z = 1.11$, $p = .398$. Three-year-old children did not match powerful faces and bodies at rates exceeding chance, $M = .57$, $SD = .19$, $Mdn = .55$, $z = 1.13$, $p = .104$, while both 4- and 5-year-old children performed significantly above chance; 4 years: $M = .83$ $SD = .22$, $Mdn = .90$, $z = 4.08$, $p < .001$; 5 years: $M = .88$ $SD = .22$, $Mdn = 1.00$, $z = 4.29$, $p < .001$.



Figure 5. Example of stimuli used in the additional experiment reported in the online supplemental material. Three-year-old children consistently labeled the more muscular person as "stronger," $M = .81$, $SD = .22$, $Mdn = .80$, $z = 4.91$, $p < .001$. See the online article for the color version of this figure.

As detailed in Figure S4 in the supplemental material, children at the youngest ages showed an approximately even distribution of matching task scores, suggesting that most did not have a strong intuition about how to complete the task. With increasing age, children more consistently paired masculine faces with expansive postures. There was no cluster of children at any age who matched masculine faces with bodies showing restrictive postures.

Associations between attribution and matching task performance. At each age, we examined correlations between the proportion of anticipated responses on each trial type of the attribution task, and the proportion of anticipated responses on the matching task. Table 1 displays these bivariate Spearman correlations. At 3 years, no correlations were significant. At 4 years, there was a positive correlation between children's scores on the matching task and their attributions of strength from facial structure. At 5 years, children's scores on the matching task were correlated with their attributions of strength from facial structure and their attributions of authority from both facial structure and body posture.

Discussion

Experiment 2 provides a number of insights into the development of children's reasoning about powerful people and their appearances. The results from the attribution task suggest that, as children age, their attributions of power increasingly incorporate the appearance-based cues examined here. Moreover, they come to view both masculine facial structure and expansive body posture as evidence for both strength and authority. The results from the

matching task further suggest that, during this same developmental period, children's representations of powerful facial structure and body posture exist within a conceptual framework that allows them to draw connections between different appearance-based cues. Yet, the developmental trajectory documented here is not simply one of increasingly adult-like intuitions: Unlike adults, even 5-year-old children confidently attributed strength from expansiveness in body posture.

A limitation of Experiment 2 is that children's participation in the attribution task may have influenced their performance on the subsequent matching task. Although the experimenter did not provide feedback on either, the attribution task may have increased the salience of the physical differences between high and low power characters or oriented children toward considering strength or authority when encountering the same stimuli again. Experiment 3 addresses these considerations by testing a new group of participants on the matching task alone.

Experiment 3

Experiment 3 was a direct replication of the matching task from Experiment 2, conducted with a group of children who had not previously performed the attribution task. The experimenter made no comments about power, strength, or authority, and this was children's first encounter with the face and body images. Consequently, matching powerful faces and bodies in the predicted manner could only be based on children's preexisting expectations about how these two aspects of appearance should align.

Method

Ninety-six 3- to 5-year-old children, divided equally across three age groups, participated in the study (3-year-olds, 13 females: $M_{\text{age}} = 3.51$ years, $SD = .29$; 4-year-olds, 13 females: $M_{\text{age}} = 4.53$ years, $SD = .31$; and 5-year-olds, 23 females: $M_{\text{age}} = 5.52$ years, $SD = .27$). Children were typically developing, exposed predominately to English ($\geq 70\%$), recruited from the same database utilized in Experiment 2 ($n = 44$) and from a children's museum ($n = 52$) in Baltimore, MD. The demographics of both samples were similar. Caregivers identified their children as primarily White (67.7%), Black/African American (14.6%), or Asian (7.3%). The remaining children were identified as either Native American, Hispanic, or Other. The modal annual income for families was over \$100,000. Children who participated individually in a university research lab received a small toy. Children who participated individually at the museum did not receive compensation.

Eight additional children were tested but excluded from analyses because of a video recording error (two 3-year-olds), an experimenter error (one 5-year-old), failing to complete the study (one 4-year-old), parental interference (one 4-year-old), a parent-reported developmental delay (one 4-year-old), or not meeting the language requirements (two 5-year-olds).

Results

Figure 4 displays children's performance in Experiment 3. Our analytic approach was identical to Experiment 2's matching task. The main analysis did not reveal a significant effect of Age Group,

$\chi^2(2) = 4.28$, $p = .118$. However, to provide continuity with our examination of the age differences found in Experiment 2, we again compared responses at each age to chance performance. Both 4- and 5-year-olds matched powerful faces and bodies; 4 years: $M = .61$ $SD = .23$, $Mdn = .60$, $z = 1.95$, $p = .013$; 5 years: $M = .66$ $SD = .29$, $Mdn = .70$, $z = 2.43$, $p = .003$. Three-year-old children did not, $M = .54$ $SD = .18$, $Mdn = .50$, $z = .48$, $p = .330$.

Overall, children in Experiment 2, $M = .76$, $SD = .25$, $Mdn = .90$, performed better than children in Experiment 3, $M = .61$, $SD = .24$, $Mdn = .60$; unpaired Mann-Whitney test: $z = 4.06$, $p < .001$. Children's performance did not vary across testing locations (University or Children's museum; $\chi^2(1) = .45$, $p = .498$), nor were there any interactions involving this factor ($X^2s < .36$).

Discussion

Experiment 3 confirmed the findings from Experiment 2. By age 4, children matched powerful faces with powerful bodies, demonstrating that they see correspondences between power-relevant variation in separate aspects of appearance and are capable of aligning appearance-based cues together. Children's ability to match power-relevant variation in faces and postures does not depend on prior experience with these specific stimuli or labeling them in similar ways. However, there was some suggestion that scores on the matching task in Experiment 2 were influenced by children's recent experience of the attribution task: Without prior exposure to the stimuli, 3-year-old children did not even perform marginally above chance, and older children's performance in Experiment 3 was lower than in Experiment 2.

General Discussion

We examined children's and adults' abilities to meet two basic challenges of navigating unfamiliar social environments: determining who is powerful from limited social information (i.e., physical appearance) and recognizing that power can arise from many sources. Three questions guided our investigation: When do children first become sensitive to physical appearance cues that adults view as powerful? Do children draw connections between different aspects of appearance that may provide information about a person's power? What range of power concepts do children associate with different aspects of appearance? We found that, over development, children view different aspects of appearance and different notions of power as increasingly connected. However, neither their sensitivities to powerful appearance cues nor their attributions of power develop uniformly. We suggest that the complexity of findings documented here is unlikely to be explained by a single developmental mechanism. Instead, our data help generate novel, integrative suggestions regarding the origins of our ability to judge and reason about the power of other people.

Detecting Power From Appearance

We used multiple methods to assess children's developing sensitivity to the same physical cues that adults find powerful. First, we examined their attributions of power from variation in both facial structure and body posture. Second, we investigated whether they associate power-relevant variation in faces with power-relevant variation in postures. This provided a detailed description of how early representations of powerful appearance emerge.

Children were sensitive to power-relevant aspects of facial structure by 4 years, choosing faces with more masculine features as both stronger and in charge. This finding converges with results from Cogsdill and colleagues (2014); however, that work pooled 3- and 4-year-old children together, potentially obscuring developmental changes during the early preschool years. Because 3-year-olds did not make consistent judgments about faces in the present study, children may become attuned to power-relevant aspects of facial structure between 3 and 4 years of age.

Sensitivity to power-relevant aspects of body posture emerged earlier, at the youngest age tested: 3-year-olds indicated that people holding expansive postures were stronger than those with more restrictive postures. As prior research had only provided clear evidence that 5-year-old children make inferences about power from postural information alone (Brey & Shutts, 2015), this finding motivates a substantial update to our understanding of the timeline along which children first become sensitive to this aspect of powerful appearance.

Claims about the trajectories of children's emerging sensitivity to powerful faces and postures require confidence that the experimental procedures were appropriate for all ages tested and clarity about what those procedures assessed. Our procedure for investigating children's attributions from isolated physical cues was highly similar to studies in which children as young as 3 years have demonstrated consistent power attributions (Brey & Shutts, 2015; Charafeddine et al., 2015; Gülgöz & Gelman, 2017). Moreover, the supplemental experiment assessing 3-year-olds' attributions of strength from musculature yielded highly consistent responses, demonstrating that children are not confused by the task when they hold strong intuitions about the associations under investigation. Based on these considerations, we believe that the developmental trajectories observed here document real changes in children's explicit reasoning about the physical manifestations of power. Yet, we acknowledge it is possible that other procedures might reveal sensitivity to powerful appearances at ages younger than those reported here. If so, it will be important to determine whether procedures might also tap different types of representations (e.g., explicit vs. implicit social knowledge).

One benefit of including the matching task in the present study is that it placed fewer demands on children's performance than the attribution task. Children were instructed to pair faces and bodies together, but their responses did not require communication back to the experimenter. Furthermore, because the experimenter never indicated what rule should be used for matching, children could have responded "correctly" without reflecting explicitly on how to align the images. Additionally, children may have matched faces and bodies on dimensions other than strength or authority (e.g., anger or pride; Nelson & Russell, 2012; Tracy et al., 2005). In light of these considerations, if children were sensitive to power-relevant aspects of facial structure earlier than the attribution task revealed, then 3-year-olds might have matched faces and bodies in a consistent manner. The timing of children's first success—that is, age 4 in both Experiments 2 and 3—suggests that children first view power-relevant variation in both facial structure and body posture in similar ways at 4 years, but not earlier.

Four-year-old children's success on the matching task also contributes new insights into their reasoning about the physical manifestations of power. One functional benefit of seeing correspondences between powerful faces and bodies is that an observer

may arrive at a more accurate estimation of someone's power level by pooling information from different sources. Our matching task indicates that children draw connections between power-relevant variation in distinct perceptual representations, thereby motivating future research investigating what additional computations these connections may support. Such research may also reveal whether children represent a direct association between power-relevant variation in faces and postures, or whether they see correspondences because they link each cue with the same notion of power.

Recognizing Multiple Forms of Power

We also examined children's reasoning about different sources of power. Prior research has only demonstrated that young children use variation in facial structure to determine strength and variation in body posture to determine who is in charge (Brey & Shutts, 2015; Charafeddine et al., 2015; Cogsdill et al., 2014). We replicated these earlier findings, but also tested the complementary inferences for the first time. Four- and 5-year-olds attributed both strength *and* authority from facial structure *and* body posture, demonstrating that children attribute multiple notions of power from a single aspect of a person's physical appearance. More generally, it suggests that preschool-age children's understanding of power weaves together notions of both physical formidability and normative authority.

Several observations suggest that children initially view an individual's appearance as more indicative of physical strength than authority. First, 3-year-olds treated expansive posture as evidence for strength but not authority. Although children might better understand other terms describing authority (e.g., being a "leader"), it is unlikely that a misunderstanding of in charge can account for the overall pattern of 3-year-old's responses. Multiple studies indicate that 3-year-olds understand the term in charge and the definition we used to explain its meaning (e.g., Brey & Shutts, 2015; Charafeddine et al., 2015; Gülgöz & Gelman, 2017). Second, even when children inferred both strength and authority from physical appearance, they had stronger intuitions about strength. Third, in Experiment 2, of all four cue/attribution combinations, 4-year-olds' ability to match faces and bodies was uniquely associated with the extent to which they viewed powerful faces as strong. This is notable because 3-year-olds already infer strength from body posture. When children first detect correspondences between powerful faces and bodies, they may view such appearances as characteristically strong, not in charge.

Yet, the judgments made by younger children and adults diverged from those of 4- and 5-year-old children. This suggests that a fully interwoven conceptual structure, in which both strength and authority can be inferred from both facial structure and body posture, is neither how power understanding first emerges nor how it matures. These observations, as well as those discussed earlier, support new ways of thinking about the origins of our intuitions about the physical manifestations of power.

Developmental Mechanisms Producing Intuitions About Powerful Appearances

To date, three general accounts have sought to explain why people hold the intuitions about powerful appearances that they do. One position—the *evolutionary hypothesis*—is that present-day

judgments are based on innate associations that had predictive value in the past, even if some are no longer true (Lukaszewski et al., 2016; Sell et al., 2009; Zebrowitz, 2017). This account has been offered to explain both the attribution of leadership qualities to particular facial structures (Van Vugt & Grabo, 2015) and the conceptual link between formidability and authority (Lukaszewski et al., 2016). A second position—the *overgeneralization hypothesis*—allows that observers may innately attribute formidability from appearance, but proposes that they attribute other traits (e.g., social dominance) via heuristic processes that lead them to infer “too much from too little” (Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015). Additionally, because some permanent features of appearance resemble momentary emotional expressions (e.g., a pronounced brow may look like a flash of anger), observers may attribute other personal characteristics (e.g., aggressiveness) from which they infer additional forms of power (e.g., social dominance). Lastly, a third position—the *cultural hypothesis*—rejects evolutionary specializations entirely, suggesting that associations between physical appearance and traits like dominance are cultural constructions learned during development (Over & Cook, 2018).

There are strengths to each of these accounts. Each identifies developmental mechanisms that may indeed contribute to our intuitions about powerful appearances (i.e., evolved biases, generalizations from similar representations, and cultural input). Moreover, each account is consistent with a curious fact about intuitions in this domain: Although judgments can be highly consistent across observers, they are not always accurate (Todorov et al., 2015).

Yet, none of these accounts can explain the full pattern of results documented here. For example, a limitation of both the overgeneralization and cultural hypotheses is that they are primarily based on data regarding impressions from facial information. Consequently, they are largely silent on how the development of impressions from postures or other body information might relate to the development of impressions from faces. In principle, these accounts could be broadened in scope, as the mechanisms they identify might also underlie the emergence of children’s attributions from powerful postures. However, the present data highlight aspects of children’s intuitions that all three accounts would need to explain, such as children’s greater consistency overall when making judgments from postures and about strength.

We suggest that a comprehensive explanation of how children’s intuitions about powerful appearances develop will be most straightforward if it incorporates the developmental mechanisms hypothesized by each of the three accounts summarized above. Furthermore, additional developmental mechanisms not currently described by these accounts may also be involved, and we believe that our study’s matching task reveals one such possible mechanism. We illustrate our proposal in the remainder of this section.

The age at which a capacity first emerges cannot be taken as decisive evidence for the degree to which it develops from innate foundations or individual learning. Learning can happen quickly, and innate systems may be timed to coincide with later-occurring biological or social processes. Nevertheless, an earlier developmental trajectory does provide insight into the quantity and quality of experience that may be necessary for the capacity to arise. Thus, it is informative to consider which of preschoolers’ intuitions about powerful appearances may have roots in capacities already present in infancy—or even in other species.

Children’s initial tendency to infer strength from appearance accords well with the view that humans possess early emerging, specialized capacities for assessing the physical formidability of others (Sell et al., 2009). However, differences in children’s impressions of strength and authority run counter to one of the distinctive claims of the evolutionary hypothesis, which predicts that children’s impressions of strength should immediately engender impressions of authority (Lukaszewski et al., 2016). Although the present work targeted ages at which children already have abstract concepts of both strength and authority, their greater abilities to infer strength from appearance echo the earlier development of these notions. Demonstrations of infants’ reasoning about power are best understood as formidability judgments, based on an agent’s appearance (e.g., body size; Thomsen, Frankenhuus, Ingold-Smith, & Carey, 2011), coalitional strength (Lourenco, Bonny, & Schwartz, 2016; Pun, Birch, & Baron, 2016), or victory in a physical struggle (Enright et al., 2017; Gazes & Hampton, 2015; Mascaro & Csibra, 2012, 2014). Only after their second birthdays do children identify a more powerful individual on the basis of others’ deferential behavior, as opposed to physical domination (Thomas, Thomsen, Lukowski, Abramyan, & Sarnecka, 2018). One way to interpret these findings is that children’s earliest notions of power center on formidability and include associations between appearance (i.e., body size) and formidability. Later, children may develop notions of authority that are distinct from formidability and not yet associated with specific aspects of appearance.

Children’s sensitivity to body posture may also be more evolutionarily constrained than their intuitions about powerful faces. Many nonhuman species use posture to inflate their apparent size during dominance displays (Mazur, 1985; Weisfeld & Beresford, 1982), and, as noted above, preverbal infants use body size to predict the victor of physical contests (Thomsen et al., 2011). These findings suggest that a single, evolved capacity may infer formidability from an individual’s size, and that postural expressions capitalize on this system across the animal kingdom. An open question is whether posture is initially linked to children’s impressions of power by affecting an individual’s apparent size (as appears to be the case in adults), or whether an expectation that body information reflects physical power may heighten children’s sensitivity to culturally provided associations between posture and strength (a less explored proposal).

Why did children’s sensitivity to powerful facial structure emerge later? Unlike studies on sensitivity to body information, there is currently no wider set of findings with infants and other species to support the proposals of the evolutionary and overgeneralization hypotheses that innate biases shape our sensitivity to powerful faces. Yet, neither is there much evidence that learned stereotypes about powerful appearance contribute to early face attributions, as the overgeneralization hypothesis also proposes—and which is the main driver of developmental change described by the cultural hypothesis. Future research should first replicate children’s delayed sensitivity to powerful facial structure, and then investigate the extent to which innate biases and individual learning are involved.

It is also unclear how children come to associate appearance with authority. Although more research is needed, we suspect that processes of generalization are involved. A recent extension to the overgeneralization hypothesis describes how this might work.

Whereas the overgeneralization hypothesis has traditionally emphasized how similar appearances may be mistaken for one another, the new perspective proposes that trait judgments from appearance are also shaped by an observer's expectations for correlations among traits (Stolier, Hehman, & Freeman, 2018). This proposal generates a straightforward empirical prediction: As children develop abstract expectations that strong people hold authority, they should also attribute authority from the same appearances that they view as indicating strength.

Children's success on the matching task highlights an additional, previously unconsidered, mechanism that may support the development of intuitions about powerful appearances: The ability to see correspondences between power-relevant variation in facial structure and body posture may make additional generalizations possible. For instance, children's early sensitivity to power-relevant variation in posture, coupled with cultural depictions uniting postural expansiveness with particular facial types, may actually scaffold their initial detection of power-relevant variation in facial structure. As another example, if children believe that facial structure and body posture go together because they both manifest an individual's strength, then additional inferential processes leading children to attribute authority to some facial structures may entail that similar attributions extend to their associated postures. These examples demonstrate how a more detailed description of children's intuitions, across multiple aspects of appearance, can improve accounts of the mechanisms underlying the development of our intuitions about powerful appearances. Moreover, this approach can be extended to better understand how children construct increasingly complex representations of those with power. Future work should investigate the timeline along which other power-relevant cues, such as height, musculature, or vocal modulation (Feinberg, DeBruine, Jones, & Little, 2008; Fessler et al., 2012; Han et al., 2017; Pietraszewski, Wertz, Bryant, & Wynn, 2017), are also integrated with the representations examined here.

Reasoning about the physical manifestations of power continues to develop after the preschool years. Five-year-olds and adults have similar intuitions about faces but diverge sharply in what they infer from body posture. This contrast suggests that the developmental mechanisms producing our initial intuitions about powerful appearances may differ from those that underlie the later refinement of these intuitions. Whereas the focus during early childhood may be on building up a conceptual structure that increasingly draws together representations of different aspects of appearance and notions of power, later development may be geared toward pruning back the least likely of these associations. After all, as adults recognize, even people who are not strong can adopt the posture of those who are in charge.

The contrast between children's and adults' attributions also raises a novel question about adults' intuitions: If adults are capable of scaling back some inaccurate intuitions (e.g., a strength-posture link), why do they appear not to scale back others? As other researchers have discussed extensively, trait attributions from facial structure are often inaccurate, yet here adults viewed certain faces as holding more authority than others. Perhaps adults distinguish between immutable physical characteristics and expressions that can vary across contexts. Future research might investigate whether impressions from inherent features like facial

structure are more difficult to revise (or suppress) than impressions from variable behavior like posture.

Study Limitations

Several considerations constrain the generalizability of our findings. First, our stimuli depicted computer-generated faces and bodies. Although this ensured that the stimuli varied only along the dimensions of interest and did not include elements that might provoke unrelated attributions, the artificiality of these images may have undermined their ecological validity. For example, the appearance manipulations may have produced faces outside the range children's typical experiences. Future work might examine whether children respond more strongly to photo-realistic images, even for more subtle differences in appearance.

Second, our stimuli depicted individuals from a limited range of social identities. Targeting intuitions about male faces and bodies provided continuity with prior developmental and adult research (Cogsdill et al., 2014; Oosterhof & Todorov, 2008; Todorov, Mende-Siedlecki, & Dotsch, 2013; Todorov et al., 2015). However, observers' stereotypes about powerful appearances may vary according to a target's sex, age, race, or other social category memberships (Stolier et al., 2018). For example, adults are more likely to conflate notions of strength and authority when assessing male, relative to female, faces (Toscano et al., 2016). We do not assume that our findings generalize to judgments about people with other social identities.

Third, although we recruited participants from multiple cities in both private and public settings, all were part of either urban or suburban mid-Atlantic communities in the United States, and all were part of WEIRD culture more broadly (Henrich, Heine, & Norenzayan, 2010). It would be important to know whether our findings extend to other cultural contexts, particularly as social category stereotypes are culturally variable. Further, intuitions about the sources of normative authority may be more culturally variable than intuitions about the sources of physical strength. Future research would benefit from exploring development trajectories in communities that diverge in theoretically significant ways from the one that we observed. For instance, how might children respond if raised in communities that are female-dominant, egalitarian, or that encourage gender-neutral socialization (Begler, 1978; Goettner-Abendroth, 2018; Shutts, Kenward, Falk, Ivegran, & Fawcett, 2017)? Cross-cultural investigations such as these would help to disentangle the contribution of evolved and learned influences on children's judgments.

Lastly, our procedure does not reveal whether children's responses were guided by attending to the more or less powerful character paired within a display. Children may have labeled the more masculine face as stronger by either inferring physical strength from its structure directly, or by reasoning disjunctively from the less masculine face. In the matching task, children may have aimed to make either the low- or high-power images go together. Our conclusions about children's sensitivity to variation in posture and facial structure are consistent with any of these possibilities. Further research could resolve this ambiguity by asking children to compare high or low power images to a "neutral" image.

Conclusion

This study is the most detailed description to date of children's developing intuitions about the physical manifestations of power. Our results provide multiple insights into the emergence and trajectory of these intuitions, highlighting the virtues and limits of existing developmental accounts. The complexity and timing of these changes also motivate new hypotheses about the mechanisms underlying the emergence of children's intuitions.

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