CHILD DEVELOPMENT PERSPECTIVES

Foundations of Reasoning About Social Dominance

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ABSTRACT—***Understanding the factors that shape the social landscape is essential for living in a group, where dominant individuals often have greater control over and access to desired resources such as food and mates. Recently, researchers have demonstrated that preverbal infants, similar to their nonhuman primate relatives, already possess the cognitive schemas necessary to represent social dominance in relationships, using ecologically relevant cues such as relative physical size and group size. In this article, we discuss the phylogenetic and ontogenetic origins of infants' and children's capacity to represent social dominance in relationships and hierarchies, and examine how these initial representations are enriched across early childhood.***

KEYWORDS—social dominance; infancy; cognitive development; social status

INTRODUCTION

Navigating the complexities of social relationships is a fundamental task that many animals face throughout life. Although social animals must cooperate, conflict over valuable resources such as food, territory, and mates inevitably occurs. Pursuing such resources through physical competition can be costly as it may result in injury or death (1, 2). To help competitors assess their likelihood of succeeding or failing before engaging in a direct competition, cognitive and behavioral adaptations have evolved that facilitate the ability to detect and track cues to social dominance, thereby supporting the formation and maintenance of social hierarchies (3–5). Similar to how the biological (6), cognitive (7), and social sciences (8) define dominance, we treat it as the tendency for an individual or group to prevail and exert influence over a subordinate individual or group. Dominance confers differential access to desired resources, such as food, mates, and territory (acquired through superior competitive skills or relinquished by subordinates), thereby promoting greater chances of survival and reproductive success. Consequently, aligning oneself with a dominant individual can be beneficial, as individuals of higher status can confer benefits, such as resources and protection, to subordinates.

In this article, we propose that the cognitive capacities necessary for detecting dominance relations evolved in our nonhuman primate ancestors and may have been preserved in human lineage, as evidenced by young infants. We begin by outlining the evolutionary pressures that likely perpetuated the development of cognitive adaptations that aid in detecting ecologically relevant cues to social dominance. Then, we address whether human infants can establish representations of dominance using cues to which nonhuman primates are sensitive. Last, we discuss how representations of social dominance can influence young children's capacity for cultural learning.

CUES TO DETECTING DOMINANCE

Physical size is often associated with dominance ranking in conflicts both within and between species, with larger individuals often benefiting from greater strength and power over smaller individuals (9). Indeed, natural selection has favored adaptations that exploit this inference, so that when some species are threatened, they adopt postures that make them appear bigger to intimidate an opponent (9, 10).

Although, physical size is a reliable cue to dominance in many social and nonsocial animals, one cue to dominance that is apparently unique to animals who live in groups is the

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number of allies an individual has. The importance of tracking group size is illustrated by chimpanzees, which use different tactics to advertise their numerical strength while patrolling the borders of their territory (11, 12). Signals indicating the size of one's group can be detected both visually and acoustically (2, 13, 14). For example, to advertise the numerical strength of their group to others (11, 12) and deter opposing groups from approaching (15), both male and female chimps engage in noisy pant-hoot calling. And both chimpanzees and lions are more likely to engage in conflict if they outnumber intruders, but will stay silent or retreat if they do not (13, 14). In summary, a group is more likely to compete if it has more individuals than the opposing group (14, 16).

DEVELOPMENTAL FOUNDATIONS OF REASONING ABOUT SOCIAL DOMINANCE

Paralleling findings with nonhuman primates, preverbal human infants use cues such as relative physical size and numerical group size to infer social dominance between competitors (2, 7, 14, 17). In one study (7), preverbal infants inferred social dominance relationships by comparing the physical size of two competing agents. Infants were introduced to two agents (one twice as large as the other), each with the apparent goal of crossing to the opposite side of a platform. When both agents tried to cross at the same time, they met on the path. Then, infants were shown two scenarios: one in which the larger agent prevailed and one in which the smaller agent prevailed. Although 10- to 13-month-olds expected the larger agent to be dominant, 8- to 9-month-olds failed to demonstrate an expectation about which agent should prevail. This suggests that only older infants could use the relative physical size of two competing agents to infer which one would get the right of way. Because younger infants did not reliably use physical size as a cue to social dominance, it was unclear whether they were incapable of representing dominance relationships in general or simply were insensitive to this particular cue.

Physical size is not always an ecologically reliable cue, especially among species that form cooperative social relationships with conspecifics (6, 18). For example, in some primate species (e.g., chimpanzees), competing males may not differ greatly in size. Consequently, a male striving to achieve a position of high status may not be able to attain this on his own, but can succeed if he forms alliances with other males (19–21). This demonstrates that high-status positions are not necessarily reserved for the largest individuals, but can be achieved by smaller (or younger) individuals that cultivate social alliances (6, 18).

In another study (17), we examined whether infants' understanding of social dominance extends beyond physical size—to numerical group size—and if so, whether such sensitivity emerges earlier in development than a sensitivity to physical size. Similar to the methods used in an earlier study investigating infants' ability to use physical size as a cue to dominance (7), 6- to 12-month-olds were familiarized to an agent from each group independently achieving the goal of crossing a platform. Each of the competing agents were the same size, but differed in the number of members of the group to which it belonged (one belonged to a group of three members and the other to a group of two). When both competing agents attempted to cross the platform simultaneously, they bumped into one another. Then, infants viewed two outcome trials, one in which the agent from the larger group prevailed and one which the agent from the smaller group prevailed. Infants expected the agent from the larger group to succeed. This demonstrates that infants use the numerical size of a group as a cue to social dominance and expect an agent from a numerically larger group to be dominant. In this study, the other group members did not assist during the event. Thus, the fact that these infants inferred which agent would be dominant through their alliance with a larger group suggests that infants may understand that the presence of group members confers an advantage, even when those members are not involved directly in conflict.

As with nonhuman primates, humans recognize dominance relationships when agents forfeit desired resources to the dominant agent. For example, in one study (22), 9- and 12-month-olds were shown a video of an animated agent collecting small objects. When another agent entered, the first agent stopped collecting the desired objects, allowing the second agent to gather the remaining objects. By forfeiting the remaining objects, the first agent was shown to be subordinate to the second agent. At test, the two agents competed for a new type of desired object, and 12-month-olds (but not 9-month-olds) were more surprised when the subordinate was allowed to take the last object, compared to when the dominant agent was allowed to take the last object. This demonstrates that 12-month-olds expected the dominant agent to obtain desired resources, even when no physical conflict occurred.

From the aforementioned studies, it is unclear whether infants can keep track of an individual's dominance over another agent across different contexts because actors in those studies were observed only once in a scenario where their dominance status was established. To investigate infants' understanding of social dominance as a stable relation, we carried out a study in which 12- and 15-month-olds were first familiarized to a dominant agent monopolizing a bounded area (i.e., pushing the subordinate away); at test, the infants were shown a novel scenario in which the previously established dominant and subordinate agents competed for a desired object. Infants viewed two outcomes: one in which the previously dominant agent succeeded and one in which the subordinate succeeded. We saw a developmental trend in which older infants demonstrated an increased capacity to track dominance relationships across different contexts. More specifically, 12-month-olds could represent the dominance relationship between two agents only when the test scenario was identical

to the conflict scenario they had witnessed. But, 15-month-olds could generalize the established dominance relationship to many scenarios. For example, if one agent had been shown to dominate a second in one setting, 15-month-olds expected the dominant agent to obtain the desired objects in all settings (22). This suggests that by 15 months, infants expect established dominance relations between two agents to be consistent over time and across contexts.

To further examine infants' capacity to track dominance relationships among individuals, researchers in another study (23) tested whether infants could represent the dominance hierarchy among three agents. Following an earlier study (22), 15-month-olds were shown three pairs of agents, each of which wanted to monopolize a confined space. Infants could recognize the dominance relationship between each pair of agents, but only when it was presented incrementally and in a linear order. For example, if infants were shown that A was dominant to B, then B was dominant to C, and C was dominant to D, they understood that A was dominant to C. However, infants could not recognize the dominance relationships if they were established discontinuously. For example, if they were shown that C was dominant to D, then B was dominant to C, and A was dominant to B, infants could not recognize that A was dominant to C. This work demonstrates that in particular circumstances, infants may use a form of deductive reasoning called *transitive inference* to derive a relationship between agents that have not been compared to one another directly.

When and how humans develop the ability to use transitive inference to reason about social dominance in relationships is not fully understood and is a matter of debate. In some studies (23, 24), transitive inference emerges as early as infancy, while in others (25, 26), the ability appears to emerge around age 4. However, this developmental discrepancy in humans' ability to use transitive reasoning may be related to the particular domain tested because sensitivity to the social dominance domain may emerge prior to domain-general reasoning.

This evidence supports the argument that transitive inference is central to social dominance cognition in humans, as it allows humans to represent the complex structures of their social groups by building on dyadic relationships. This ability is also essential for maintaining social hierarchies in other species that live in groups (e.g., nonhuman primates). However, it remains unclear whether the capacity to organize social hierarchies through transitive inference operates similarly in nonhuman primates and humans. Therefore, further investigation is needed to compare and contrast nonhuman primates' ability to build representations of social hierarchies with those of human infants and children.

EVALUATING DOMINANT INDIVIDUALS

Not only do young children recognize dominance relationships among individuals, they also appear to exhibit a positivity bias toward more dominant individuals. For example, when preschoolers view an individual behaving in a dominant way (e.g., giving orders to others), they also expect the individual to have more resources (27). In addition, children are willing to maintain and perpetuate this inequality themselves, by ensuring that the dominant individual always has more resources than the subordinate individual (28).

Why are young children willing to perpetuate inequality in this context? One reason may stem from our nonhuman primate ancestors, who affiliate with dominant individuals to increase access to coveted resources, thereby improving their dominance rank and fitness for survival. For example, male chimpanzees with lower status attempt to develop alliances with dominant individuals by attending to and appeasing the dominant chimpanzees (e.g., through grooming; 29–32).

Similarly, recent work suggests that young children may also recognize the benefits of affiliating with dominant individuals. In one study (33), researchers investigated whether 2-year-olds preferred a dominant agent over a subordinate agent. To accomplish this, they modified the dominance paradigm (7) with one important change: Both agents were equal in size. After establishing that one agent was dominant over another, researchers presented both agents to the children, placing them side by side. The children were asked which agent they liked. Two-year-olds preferred the dominant agent, suggesting that young children, like nonhuman primates, may be motivated to affiliate with dominant individuals. Whether this choice reflects a preference for dominant individuals that could share resources or provide protection, or a preference for individuals who complete their goal (akin to a success bias; see 34) requires further investigation.

PREFERENTIAL LEARNING FROM DOMINANT INDIVIDUALS

In addition to greater access to valuable resources, dominant individuals also directly influence their subordinate counterparts, as evidenced by studies with nonhuman primates in which decisions made by dominant individuals directly influenced the behavior of subordinates in different domains (35–37). For example, baboons willingly (i.e., without force or coercion) accepted and followed despotic decisions about foraging patches made by dominant baboons, even when this incurred a short-term cost for subordinates. In addition, in a recent study (38), chimpanzees were biased to learn from a more dominant individual. Researchers devised a task in which chimpanzees could acquire desired food from a box with two openings. Dominant chimps did not prefer to obtain the food from either opening. However, subordinates paid more attention to the dominant individual and appeared to imitate her manner of interacting with the box. Therefore, subordinates naïve to the box task were more likely to obtain the food from the same opening as the dominant individual they had observed, even though either opening would have provided food. This demonstration of deference to the

dominant, not only in competitive scenarios but in foraging choices and cultural learning, may reflect an evolved tendency to follow the leadership of dominant individuals.

Evidence of preferential learning from dominant individuals may reflect an expectation that dominant individuals are more optimal sources of information, all else being equal. Indeed, research with human adults seems to support this view. In one study (39), human adults rated high in trait dominance were perceived as more competent by their peers, randomly assigned group members, and even researchers blind to the hypotheses of the study. This suggests that individuals higher in trait dominance may attain social influence because they are *perceived* to be more competent, even when no evidence of competence is provided.

Like nonhuman primates, 3- and 4-year-olds show a similar learning bias, favoring the labels provided by a socially dominant individual over those of a subordinate individual in a novel word learning task (40). In this study, children were naïve to individuals' previous knowledge or history of accuracy, and only knew that one individual was dominant over the other because he had been given the right of way to cross a platform (see 7, 17). At a minimum, these results show that children are more likely to learn new information from more dominant individuals than from less dominant ones. Children's learning preference could also stem from an evaluation of individuals' competence. That is, like adults (39), young children may associate dominance with competence (even if no direct evidence of competence is observed), and that evaluation drives children's learning decisions. In addition, we also recognize that dominance and competence may influence children's preferences independently. Consequently, researchers should attempt to disentangle these possibilities by examining the specific contexts in which dominance and competence may influence children's learning decisions.

Whether children's (and chimps') preference to learn from dominant individuals includes an evaluative component remains a question, but the aforementioned results suggest that both nonhuman and human primates are predisposed to learn from dominant or prevailing individuals. This learning bias may reveal one way in which dominant individuals influence cultural learning, the products of which are passed down to later generations.

CONCLUSIONS AND LOOKING AHEAD: A PREDISPOSITION TOWARD INEQUALITY?

We argue that the cognitive mechanisms used by nonhuman primates and humans to detect and track social dominance relations may share common roots, as evidenced by a growing body of evidence in both evolutionary and psychological research. By studying, and capitalizing on, infants' early sensitivity to goal-directed action and goal attainment, we have detected infants' early-emerging recognition of dominance relationships. For instance, in much of this work (7, 17, 22), infants expect a dominant agent to accomplish his or her goal at the expense of another agent. Therefore, like nonhuman primates and adult humans, infants apparently link success (e.g., in the form of completing goals and accessing resources differentially) with dominance.

In addition, we propose that recognizing social dominance early in development is facilitated by ecologically relevant cues (e.g., relative physical size, numerical group size, amount of resources). However, we recognize that research on infants' understanding of dominance relationships and hierarchies is limited, and that infants and children may be sensitive to other cues to dominance (e.g., age, vocal tone and pitch, facial cues, and body language, including posture and other nonverbal behaviors). Given the preliminary nature of this work, researchers should investigate the developmental trajectory of reasoning about social dominance across the lifespan. Such work should focus on whether young children can recognize more nuanced cues to dominance (in particular, those unique to a particular individual), and whether such cues lead to similar inferences about dominant individuals (e.g., decisions about with whom to align or from whom to learn).

Given that culture can also affect social evaluations significantly, it is important to consider how socialized values may moderate perceptions of dominance and status over time. For example, in a recent study with human adults (41), explicit associations between social status and numerical group size may have been shaped by the beliefs and social norms reinforced by culture: Americans were more likely to explicitly associate smaller groups with higher status, rationalizing that smaller groups are more exclusive and elite, and that they represent the richest 1% in the country. In contrast, implicit measures—designed to tap unconscious and automatic associations—revealed the opposite association: Larger groups were associated with higher status. This finding demonstrates that culturally acquired values can lead to judgments about dominance that differ from those based on the mechanisms that humans share with nonhuman primates.

Finally, human infants' expectations that one individual is more likely to be dominant than another may reveal an early, tacit awareness of inequality in social relationships. As such, we cannot help but wonder whether this early awareness contributes to children's and adults' tendency to reinforce, provide justification for, and even favor inequality in social relationships (27, 42–45). Some studies have investigated whether an individual's position in society affects children's social preferences regarding that person. For example, 5- to 7-year-olds prefer advantaged over disadvantaged groups (44), and as early as age 2, children prefer dominant over subordinate agents (33). These choices may reflect an implicit understanding that being affiliated with advantaged or dominant individuals can be beneficial. As such, researchers need to determine whether young children's underlying motives are ultimately self-serving if dominant individuals are viewed as sources of protection, distributors of resources, or

valuable sources of information. These questions require further exploration, and the answers may help explain why prejudice is so widespread, and why fairness and tolerance can sometimes be difficult to attain.

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