To Copy or To Innovate? The Role of Personality and Social Networks in Children's Learning Strategies

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ABSTRACT—*In our technologically complex world, children frequently have problems to solve and skills to learn. They can develop solutions through learning strategies involving social learning or asocial endeavors. While evidence is emerging that children may differ individually in their propensity to adopt different learning strategies, little is known about what underlies these differences. In this article, we reflect on recent research with children, adults, and nonhuman animals regarding individual differences in learning strategies. We suggest that characteristics of children's personalities and children's positions in their social networks are pertinent to individual differences in their learning strategies. These are likely pivotal factors in the learning strategies children adopt, and thus can help us understand who copies and who innovates, an important question for cultural evolution. We also discuss how methodological issues constrain developmental researchers in this field and provide suggestions for ongoing work.*

The world is developing at an unprecedented pace and we encounter technological advancements at ever-increasing frequencies. Because of these developments, children regularly face novel problems not faced by their parents' generation. Children must decide whether to develop solutions to these problems by using social information acquired from others (social learning) or through their own endeavors (asocial/individual learning). Both learning strategies call for specific skill sets. Effective social learning requires assessing the competence and intentions of those observed and evaluating the behaviors they display (1). Asocial learning often requires creativity and innovation to derive a solution without direct help from others (2), though this can occur through understanding the causal mechanisms of a problem, trial and error, or luck. Both strategies have benefits and potential costs: Copying others is a quick, low-effort form of learning difficult skills but the learned behavior may be outdated or unreliable, while asocial learning provides direct, reliable information but can be risky and take time. Thus, children face a trade-off when deciding how to solve novel problems.

Although the same mechanisms of associative learning may underlie both asocial and social learning (3), tentative evidence suggests that adults differ in their propensity to solve problems socially or asocially; individuals from collectivist societies (compared to individualistic ones) and those who are rated as more socially dominant are more likely to use social information, while those with lower IQs are less likely to learn socially (4). This probably occurs because each learning strategy requires specific skill sets. Why some children show a greater propensity or capability to solve problems by observing peers while others to do so on their own is an understudied area in developmental psychology. In this article, we argue for an investigation of whether children differ in their preferred learning strategies, and if so, an inquiry into what underpins the differences between those who are more likely to solve problems

asocially or socially. Concurrently, we acknowledge that methodological and practical challenges may hinder researchers' attempts to answer these questions, and we explore some of these challenges and suggest fruitful approaches.

At the heart of our technological advancement is the capacity for cumulative culture, where cultural traits are retained via social learning until innovations occur and are incorporated, ratcheting up complexity and efficiency over generations (5). Accordingly, innovation—generating novel solutions to problems—and social learning are keys to cumulative culture (6). New cultural traditions require innovations to establish novel behavioral patterns and their subsequent diffusion throughout populations. A greater understanding of what may differentiate children who are more likely to innovate behaviors from those who are more likely to spread innovations socially will provide insights into our cultural success. Asocial and social learning are not necessarily dichotomous choices; both learning strategies are available to all children, and children may differ in their propensity to use either one. Generally, humans are poor individual innovators (7); cultural innovations tend to be driven by the ability to build upon others' actions (or social learning; 8). However, for clarity, and because they are commonly explored separately, we look at the literature on these two processes independently.

DO CHILDREN WHO TEND TO LEARN ASOCIALLY DIFFER FROM THOSE WHO TEND TO LEARN SOCIALLY?

Asocial and social learning are assessed by presenting novel problems involving apparatus or tools that can be solved socially or asocially. The ontogeny of tool use is of interest because tool use characterizes all human environments, is fundamental to cumulative culture, and is learned early. Children are excellent social learners (9), but they find solving innovation challenges difficult asocially, especially in early childhood, with most children under age 8 failing innovation challenges (7).

When presented with novel puzzle boxes and given the choice of first observing demonstrations or electing to solve the task asocially, most 3- to 5-year-olds use social information (i.e., observe demonstrations) instead of attempting to solve the task individually (1, 10). This occurs across a wide age range (4–9 years), even when the social information, provided by an adult, is demonstrably unreliable (9). In a complex, tool-rich world, the tendency to readily imitate others allows children to rapidly learn important and difficult behaviors (11).

Context also plays a role in children's choice of learning strategy. The individuals from whom children learn (12), the instructions given, (12) and the inferred goals of the actor (13) all affect whether children copy others. For instance, children prefer to copy older, proficient children who are similar to them, as well as models who show clear intentions to teach (12). Although use of social information is positively correlated with

complexity of task in callitrichid monkeys (14), difficulty of tasks had no influence on 3- to 5-year-olds' propensity to solve problems asocially or socially (10). Despite the role of context, children may differ in their inherent propensities for social or asocial learning. Across studies, few children tackle novel problems individually. Is the identity of this minority consistent and if so, what facilitates their choice to go it alone? Without investigating whether the propensity to use specific learning strategies differs consistently by individual, we cannot be certain whether context, individual-level factors, or a combination of both predict children's choices of learning strategy.

Many intrinsic factors could affect children's use of learning strategy. Research in related fields—notably studies of adults and animals—can supplement the limited research on children (15, 16) by revealing individual differences of interest. Accordingly, we suggest that researchers start by investigating factors (e.g., personality and position in the social network) that may play a role in the learning strategies children adopt and that are intrinsically linked to each other (17).

PERSONALITY

Personality traits begin to stabilize in midchildhood (18) and they shape how children solve problems and interact with others, as well as their academic and creative achievements (19). Thus, personality should influence the propensity to adopt specific learning strategies. The few studies that have tested this idea have focused on a limited range of personality traits, particularly extraversion, the tendency to be sociable, bold, active, and dominant. Twelve- to 15-month-olds rated highly by parents on extraversion (scored at 4 and 15 months) imitated adults more faithfully during games with toys than infants with low extraversion ratings (20). In addition, 2- to 4-year-olds rated as dominant were observed more by class peers when using a puzzle box task (21). Similarly, parents' ratings of extraversion predicted their 3-year-olds' success in judging others as reliable sources of information but children's language scores did not (22). The social nature of extraverts potentially raises use of social information through increased motivation for social interaction (20), or greater proficiency at judging social environments, ostensibly due to more diverse social experiences (22).

In research with adults and animals, characteristics related to extraversion positively influenced use of social information. On an image identification task, adults' social dominance predicted reliance on social information (16). Compared with introverts, extraverts are also more attracted to and neurologically process social stimuli differently (23). In studies of animals that included baboons (15), great tits (24), and guppies (25), boldness (a facet of human extraversion) correlated positively with use of social information in foraging tasks.

Thus, in children, adults, and animals, some personality traits may predict the use of social information in making decisions and solving problems. Extraverted, sociable, and bolder

individuals tend to use social information more than introverted and shyer individuals, perhaps because of their greater motivation for or access to social interaction and stimuli. However, researchers need to explore a wider range of personality characteristics.

Asocial problem solving requires different skills than social learning. In particular, creativity and innovation are required to generate appropriate solutions without social information (2). Thus, the relationship between personality and these particular characteristics is pertinent. While we know that most young children struggle to solve innovation tasks asocially and most children adopt social information if it is available, we know little about whether personality predicts their success and failure, and their tendency to tackle problems individually.

Adults with greater scores in openness to experience perform well on creativity tests (26). Moreover, employees who score high in openness are judged as more creative and innovative by employers than those who score low in openness (27). Openness entails being curious, artistic, imaginative, and intellectual, characteristics that seem to map on to creativity and innovation and, therefore, asocial problem solving (28). Indeed, openness in captive male chimpanzees correlated positively with success and duration of puzzle box solving and interaction (29). The construct of openness has been verified in children (30), allowing us to investigate whether children who are more open to experience are more innovative or more inclined to solve problems asocially than those who are not as open to experience.

Yet when studying personality, researchers must consider several methodological issues. Many studies of children's personality rely on parental or self-reports, but scores can vary across judges. Using many informants (including teachers) would increase reliability (31). Additionally, few studies with children have controlled for factors other than personality when investigating children's learning strategies. For example, theory of mind, IQ, or family-based factors (e.g., birth order or number of siblings) may facilitate or inhibit both the propensity to copy others and creativity. IQ is also linked with openness, which may facilitate innovativeness. To determine more precisely the role of personality and other important factors (and the relationship among them) in children's learning strategies, researchers need to consider these factors more completely.

By furthering our understanding of how a wider range of personality traits interacts with children's choices of learning strategies, we can probe other questions. For example, children rated high on agreeableness—those who are kind, caring, and cooperative—may be more likely to copy others because of their prosocial nature or a motivation to make friends. Children who score high in neuroticism (i.e., those who tend to worry) may copy others to reduce anxiety, while less apprehensive children are comfortable attempting asocial problem solving. Developmental psychologists could test these and other ideas.

Moreover, we could begin to understand whether and how personality interacts with context to influence children's learning strategies. We know little about how this interaction manifests in children when they solve problems, but research with adults provides some insights. In addition to being linked with the use of social information, extraversion increases individuals' performance on creativity tasks under test conditions (i.e., when arousal increases; 32), which may imply that arousal increases the propensity to solve problems asocially in some personality types. Similarly, adults who score high in neuroticism experience increased anxiety in social contexts when compared with those who score low in neuroticism (33). In the company of others, children who score high in neuroticism may copy others to fit in. But since neuroticism has been linked with measures of creativity (32), they may solve problems asocially in nonsocial contexts. Such investigations could provide perspectives on how personality and context interact to influence learning strategies in different situations.

POSITIONS IN SOCIAL NETWORKS

As children develop, their social networks—particularly at school—become increasingly complex, fluid, and influential (34). Indeed, the characteristics of young children's classroom social networks predict overall classroom engagement and educational achievement (35), as well as interindividual conflict (36). Here, however, we are interested in the positions that children hold within their social networks.

As with personality, individual differences in the positions children hold within their social networks likely play an important role in their choices of learning strategies, with each child's position influencing the type of social information and learning strategies they witness (37). Young children likely acquire information from those they associate with frequently and with whom they form strong bonds (21), implying that those with fewer social connections probably have fewer opportunities for social learning. Despite advances in methods to analyze social networks, we know little about the relationship between children's individual-level network positions and their use of learning strategies. Although no study has investigated this relationship directly, 2- to 4-year-olds rated as more popular by classmates were observed more, and observed others more, when interacting with a tool-use puzzle box (21). Moreover, in this study, theory of mind, sex, and verbal ability did not predict copying. Classroom popularity has been linked with network centrality (the number and strength of social relationships) in 8- to 11-year-olds (38), suggesting that highly central individuals may use social learning and facilitate it in others.

Adults are more likely to acquire beneficial or harmful behaviors from contacts in their network who are closer than those who are distant (39, 40). Indeed, in wild chimpanzees, the spread of new foraging behaviors was predicted by relationships between individuals (41). In short, in social animals (including humans), social dynamics and individual-level properties fundamentally influence the transfer of new skills and behavior.

Thus, despite limited evidence, children who are central in their social networks and who engage in frequent social interaction likely experience more opportunities to observe others and are observed more often than children who are not central in their networks. Given research suggesting that children display a range of biases to copy certain individuals (e.g., familiar, older, or prestigious others; 12) who likely hold specific positions in their networks, researchers could investigate the relationship between individual-level social network positions and social learning in children (37).

As with the use of social information, to our knowledge, just one study has investigated the role that individual-level network characteristics play in children's innovative abilities. Betweenness centrality is the act of connecting members in a network who are otherwise unconnected. Seven- to 10-year-olds who scored highly in this trait were rated most innovative in an online application design task (42). High betweenness centrality may have facilitated increased informational diversity through interaction with unconnected children in their network (42). In turn, these children synthesized information and used it to generate novel, innovative ideas. Similarly, in business settings, adult employees who score highly in betweenness centrality, and those with many weak network ties (compared to many strong network ties), are innovative and creative (as measured by publications, awards, and supervisor ratings; 43). Indeed, access to diverse information from many individuals may drive innovation in the workplace (43).

Again, the methods used in these studies require consideration to establish firmly how children's roles within social networks influence the learning strategies they choose. For instance, most studies rely on children naming their own friends to characterize social networks. While this is efficient, many informants (e.g., teachers, participants) as well as behavioral observations can be more enlightening and reliable (44). Furthermore, as with personality, factors such as theory of mind, number of siblings, and emotional quotient may affect children's positions and roles in social networks. Because this field is in its infancy, we encourage researchers to scrutinize and attempt to control for such variables.

Analysis of social networks has accelerated over the last decade, helping us understand how novel behaviors spread through human and animal populations (41). However, in the push for understanding the spread of behaviors, researchers have overlooked the role of individual network measures in identifying the innovators and determining which individuals are influential in the spread of innovations. We have outlined how we can improve our understanding of whether specific network characteristics predict children's propensity to copy others or go it alone, and highlight some extraneous variables for researchers to consider. This may help answer theoretical questions (including those of directionality) about how group dynamics influence children's problem-solving approaches. For example, children deeply embedded in their social group may preferentially elect to copy others to maintain their group position, or copying others may project children to central positions. Similarly, if popularity correlates with the tendency to use social learning (36), more innovative, asocially driven children may have peripheral network positions because they have less in common with group members. As with personality, many intriguing areas can be investigated.

PERSONALITY AND SOCIAL NETWORK POSITIONS

Ostensibly, personality and social networks are intertwined. Social, bold, and cooperative individuals presumably hold central positions in their networks, whereas reserved or less prosocial individuals hold peripheral positions. Few studies have tested this idea directly and none, to our knowledge, has done so with children. In adults' advice networks, extraversion relates positively to centrality, implying that extraversion facilitates giving and receiving advice in social groups (45). This corresponds with research discussed earlier indicating that extraversion predicts use of social information (20, 22). However, openness to experience is correlated negatively with friendship centrality, and is associated with smaller network groups and higher betweenness centrality (43, 45). The link between openness and betweenness centrality is intriguing as both predict innovation. Researchers could explore the directionality of this link: Children who interact with several subgroups may be more creative as a result or their openness to experiences may facilitate fluid network behavior.

We need to understand how personality and position in a social network interact in children, and how this interaction shapes the learning strategies children adopt. Both learning experiences and opportunities are fundamental in children's development, yet we know little about their interaction compared to adults and animals (for animals, see 46). The integration of personality and social network analysis may also help us map how cultural traditions arise. Innovations may be driven by creative personality types who are not deeply embedded within a network but who engage fleetingly with many group members. Innovations may be acquired by more gregarious, central members, facilitating their spread throughout the group through exposure to other. This is, of course, speculative, but highlights the potential of this area for cultural evolution research.

CONCLUSION

In this article, we outlined key themes for developmental researchers in the field of learning. First, when faced with novel problems to solve, children can generate solutions through social or asocial learning. Although both options are available to children, research in other fields points to individual differences in children's propensity for, and success in, copying others or innovating solutions asocially. Second, based on this research, personality and individual differences in children's positions in

social networks are two avenues of research that bear expanding. We suggest that extraverted personality types and those central in their social networks are more likely to use social information and copy others, while those who are more creative and who interact fleetingly with many members of their network are more likely to solve problems asocially. Finally, studying individual differences in learning strategy adoption is challenging for developmental researchers. Nonetheless, experimental manipulations will help control for some of the factors we have discussed. Such experimentation will require increased effort, but can help determine the existence of stable individual differences in children's propensity for, and success in, copying others or in innovating. Our species' cultural success is in no small part a result of innovations based on the use of tools, innovations that build progressively on previous generations' repertoires. Understanding whether certain individuals are more likely to invent these new behaviors while others are more influential in the spread of the behaviors (intentionally or inadvertently) can provide new insights into our cultural evolution.

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