

What is a good question asker better at? From no generalization, to overgeneralization, to adults-like selectivity across childhood

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Abstract

Prior research showed that young children prefer to seek help from actors who have demonstrated active learning competence. What inferences do people make based on the ability to search effectively, for example by asking informative questions? This project explores across two experiments to what extent adults and children (3- to 9-year-olds) generalize the ability to ask informative questions to other abilities/characteristics. We presented participants with one monster who always asked informative questions and one who always asked uninformative questions. Participants had to choose which monster they thought was more likely to possess/was better at 12 different characteristics/abilities. Our results show a clear developmental trend. Three- and 4-year-olds draw unsystematic inferences from the monsters question-asking expertise. Five- and 6-year-olds identified the better question asker as better at everything. Seven- to 9-year-olds showed adult-like response patterns, selectively associating the ability to ask good questions to related characteristics/abilities.

Keywords: active learning; social cognition; question asking.

Introduction

Children are natural born active learners. However, while some skills and knowledge (e.g., basic laws of physics or object functions) can be acquired by first-hand active exploration or from observations, some other abilities (e.g., language) strongly rely and build on social interactions. Indeed, a vast body of research suggests that children are *programmed* to learn from others since the very beginning. Already 6- to 9-month-old infants are equipped with special attentional mechanisms to detect when a social partner is willing to transmit information (Senju & Csibra, 2008; Csibra & Gergely, 2009), and 9-month-olds use strategies such as babbling or social referencing to seek explanations from their caregivers when presented with unfamiliar objects (Goldstein & Schwade, 2009; Walden, Kim, McCoy, & Karrass, 2007).

As soon as they can talk, children have more explicit ways to elicit explanations or request information: they can ask questions. Question asking is a powerful learning tool that children rely on to enlarge, deepen, enrich and adaptively revise their knowledge about the physical and social world (Callanan & Oakes, 1992; Campos, 1981; Chouinard, Harris, & Maratsos, 2007; Meltzoff, 1988b, 1988a, 1990). Previous work demonstrated that children are very selective when deciding whom to ask questions to, or more generally which informants to rely on. This research suggests that children's trust is driven by a complicated mixture of inferences drawn from the *quality* of the information provided (e.g., accuracy,

completeness; see Pasquini, Corriveau, Koenig, & Harris, 2007; Koenig, Clément, Harris, & Clément, 2004; Jaswal, Croft, Setia, & Cole, 2010; Koenig & Jaswal, 2011) and the characteristics of the *agent* providing the information (e.g., expertise, age, familiarity, culture; see Lutz & Keil, 2002; VanderBorghet & Jaswal, 2009; Kinzler & Spelke, 2011). As an example, Kushnir, Vredenburgh, and Schneider (2013) have shown that preschoolers use the quality of the information provided as a cue to infer the informants' scope of expertise. In their first study, they presented 3- and 4-year-olds with two informants (a *labeler* and a *fixer*), two familiar tools (a screwdriver and a wrench) and two unfamiliar electronic toys with interesting light or sound effects. The *labeler* provided accurate labels for the tools that he had to use to fix a broken toy, but did not manage to fix it. The *fixer* labeled the tools inaccurately but managed to fix the toys. Both 3- and 4-year-old children asked the labeler for help when they needed to know labels for novel toys, and turned to the fixer when they had to fix a broken toy, thus inferring expertise from the quality of the information provided (Kushnir, Vredenburgh, & Schneider, 2013).

Recent work shows that preschoolers are also sensitive to the effectiveness of the active learning strategies of a potential informant. In particular, children identify and rely on the most informative between two given questions already at age 4 (Ruggeri, Sim, & Xu, 2017), although they cannot reliably *generate* the most effective questions from scratch until age 10 (e.g., Herwig, 1982; Mosher, Hornsby, Bruner, J., & Oliver, 1966; Ruggeri & Feufel, 2015; Ruggeri & Lombrozo, 2015; Ruggeri, Lombrozo, Griffiths, & Xu, 2016). This research suggests that the cognitive machinery to support effective question asking may develop much earlier than the ability to generate effective questions from scratch. Why is this the case? On the one hand, it might be that what hinders younger children's effective question-generation is that their verbal abilities and vocabulary are not sufficiently developed. On the other hand, one intriguing possibility is that children's early ability to evaluate questions' informativeness allow them to assess another person's learning competence—a cue that can be used to identify role models to imitate and to *learn how to learn* from. Along these lines, a recent study showed that 3- to 7-year-old children preferentially sought help from a competent *active learner* who had figured out how to solve a problem by herself, over learners who

had learned through passive observation or direct instruction. Yet, this preference emerged only when the problem children needed to solve was similar to the one the learners had previously solved, where they thought the active learners competence would be relevant (Bridgers, Gweon, Bretzke, & Ruggeri, 2018). This paper investigates one crucial question arising from this perspective: *How* do children use active learning competence to identify role models, that is, what do they infer based on someone's ability to ask effective questions: Are good question-askers smarter, more knowledgeable, or better at solving problems? Do adults make similar inferences and generalizations? To address these questions, we explore to what extent adults (Study 1) and 3- to 9-year-old children (Study 2) generalize question-asking competence to other abilities/traits/characteristics.

We implemented a paradigm similar to that used in previous studies investigating the inferences and generalizations children make based on the informants' expertise and characteristics. For instance, Brousseau-Liard and colleagues (2010) presented 4- and 5-year-old children with two puppets that labeled 4 familiar objects. One did so correctly, and the other incorrectly. At test, children were asked to indicate which puppet they thought was more likely to possess 12 different skills/characteristics encompassing six categories: knowledge of words (e.g., Who knows words for lots of different machines?), talents (e.g. Who can draw pretty pictures?), knowledge of facts (e.g., Who knows that cats can see at night?), pro-social behavior (e.g., Who always shares her toys?), and two control-questions on possessions and situation-specific knowledge (e.g., Does she have a cat?; Who knows where I put my books?). Their results suggest that 5-, but not 4-year-olds, used the puppets' past accuracy to make explicit predictions about relevant characteristics such as her knowledge of words and facts and her pro-social behaviour, but not about her talents, possessions or situation-specific knowledge (Brousseau-Liard & Birch, 2010). Along the same lines, Lane and colleagues (2013) presented 3- to 6-year-old children and adults with three story books in which two pictured characters exhibited contrasting traits: Honest-dishonest, nice-mean, and smart-not smart. During the test phase, participants were tasked to ask - and endorse - characters' testimony about novel objects' names, about the content of a box that both characters had seen, and to attribute knowledge about the content of a different box, where only the negative informant had access to this information. Their results show that children and adults prefer to ask and endorse information about novel objects' names provided by people who are nice, honest and smart, whereas knowledge attribution seems to be influenced by the informants traits, following an age-graded decrease: 3- to 5-year-olds wrongly attributed knowledge to the positive informant, as opposed to 6-year-olds and adults, who correctly inferred the negative character's situation-specific knowledge (Lane, Wellman, & Gelman, 2013).

Based on the results discussed above (e.g., Lane et al.,

2013), we expect to find an overall age-related decrease in the extent of generalizations from question-asking expertise to unrelated traits, abilities and characteristics, with older children and adults being generally more selective than younger children (see Mills, 2013 for a review on the development of selective trust). However, because very few studies investigating generalizations of expertise have considered a broad children age range as well as adults, we don't know when mature, adult-like selectivity would emerge.

Study 1

The goal of this study was to assess adults' intuitions about the relationship between question-asking competence and 12 different abilities/traits/characteristics.

Participants Thirty adults (11 males; $M_{age} = 28.09$; $SD = 7.63$) participated in this study. All participants were recruited and tested at the Museum für Naturkunde in Berlin, Germany. Participants belonged to various social classes and were native German or fluent in German. IRB approval was obtained and participants gave informed consent to participate in the study. One additional participant was excluded from the analyses due to missing data.

Design and procedure

The procedure consisted of two phases. The familiarization phase was designed to introduce participants to two agents (i.e., monsters), one who always asks informative questions and the other who always asks uninformative questions. In the test phase, we asked participants to rate the strength of the association between the question-asking competence illustrated in the familiarization phase and 12 given abilities/traits/characteristics. We detail the two phases below.

Familiarization phase Participants were asked to read a short storybook introducing two monsters, Bobo and Kila, who ask their friend Toma some questions to find out what happened on her first day at the new school. The storybook consisted of five pages. Each of the first four pages presented a different event taking place on Toma's first day at the new school (e.g., Toma drew a surprise welcome gift from a bag; see Figure 1 for an example) and two related questions that Bobo and Kila asked Toma (e.g., "Did you get a teddy bear?" or "Did you get a red toy car?"). On the bottom of the page, 8 cliparts, arranged in a row, illustrated the options to be considered (i.e., the hypothesis space; e.g., which gifts were inside the bag). Across the four scenarios, one of the monsters always asked informative questions, whereas the other always asked uninformative questions. The informative question targeted half of the hypotheses considered, either by asking a hypothesis-scanning question that referred to a single hypothesis presented 4 times (e.g., "Did you get a teddy bear?", where there were four teddy bears in the bag), or by asking a constraint-seeking question that addressed a feature shared by four of the hypotheses (e.g., "Did you get a round-shaped toy?", where there were four round-shaped toys in the bag). The uninformative question targeted either an object that was

not included in the hypothesis space (e.g., the red toy car; hypothesis-scanning question) or a feature shared by all the objects (e.g., a toy; constraint-seeking question). A fifth page presented again the two monsters and summarized the lesson to be learned from the familiarization phase, reminding participants that “Bobo/Kila always asks good/bad questions, because they are very informative/not informative at all. She is a good/bad question asker!”

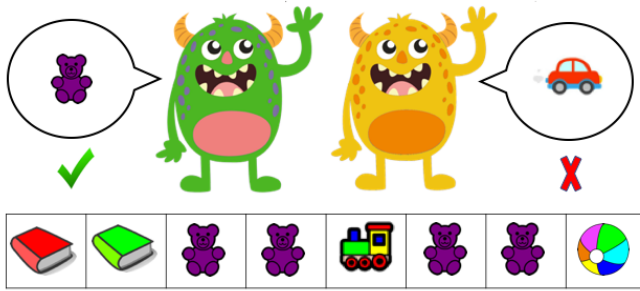


Figure 1: One scenario of the familiarization phase in which Bobo, the green monster, asks an informative question and Kila, the yellow monster, asks an uninformative question. In this example, the informative question refers to a single hypothesis presented 4 times, whereas the uninformative question targets an object that was not included in the hypothesis space.

Test phase In the test phase, participants were asked to complete a paper-and-pencil survey consisting of 12 questions, presented in random order. For each question, participants were asked to rate how much 12 different abilities, traits or characteristics (see Table 1) related to the ability to ask informative questions (e.g., “How much is being good at treasure hunting related to the ability to ask informative questions?”), on a scale from 0 (“not related at all”) to 10 (“strongly related”). The questions presented were selected to include a set of abilities/traits/characteristics of different kinds (i.e., intellectual skills vs. physical abilities, individual preferences or irrelevant characteristics) that, according to our intuitions and to pilot survey data, are more or less related to the ability to ask informative questions, e.g., involve a stronger or weaker strategic component. For instance, being good at treasure hunting or at solving riddles might require the ability to search for information and explore strategically, whereas knowing many animal names refers to a domain-specific knowledge that is more strategy-independent.

Results and Discussion

As can be seen from Table 1, “being clever” and “being good at school” were rated as the most related to the ability to ask good questions. The association with abilities with a strategic component (i.e., “being good at treasure hunting” and “being fast at completing puzzles”) were rated as medium-strong, and that with domain-specific knowledge (i.e. “knowing

many animal names”) was judged as medium-weak. Interestingly, “being friendly” was also rated as having a moderate-weak association with question-asking competency, although it had the highest between subjects variability. One possible interpretation could be that being good at asking questions is considered by some people, but not others, to indicate of a person being socially smart, sociable or just generally more likely to interact with others (Good, Slavings, Harel, & Emerson, 1987). Physical abilities or skills were rated low overall, independently of whether they were more likely to involve a strategic component (“being good at playing soccer”) or not (i.e., “kicking a ball the furthest”). As expected, individual preferences (e.g., “liking ice cream”) or irrelevant characteristics (e.g., “seeing the farthest”, “having siblings”) were rated very low, that is, were judged as not at all related to the ability to ask informative questions.

Taken together, these results suggest that adults make distinct, graded, meaningful and fairly consistent inferences and generalizations based on the ability to ask good questions. Some abilities, traits and characteristics are considered to be strongly related to question-asking competency, whereas some others are considered to be only weakly related, or completely unrelated.

In Study 2 we explored to what extent such inferences and generalizations undergo a developmental change across childhood, and when adult-like intuitions might emerge.

Table 1: Study 1. Mean ratings of the strength of the association between question-asking competence and the abilities/traits/characteristics presented to adults in Study 1.

Abilities/traits/characteristics	Mean	SD
Being good at school	8.36	1.83
Being clever	8.30	1.91
Being good at treasure hunt	6.76	2.21
Being fast at completing puzzles	5.76	2.67
Knowing lots of animal names	4.20	2.68
Being friendly	3.56	3.16
Having siblings	2.13	2.53
Being good at playing soccer	1.63	2.08
Seeing the farthest	1.37	2.35
Scoring lots of goals	1.33	2.22
Kicking a ball the furthest	1.10	2.19
Liking ice cream	0.67	1.39

Study 2

Participants Participants were 40 3- and 4-year-old children (21 males; $M_{age} = 48.41$ months; $SD = 7.19$ months), 40 5- and 6-year-olds (19 males; $M_{age} = 7.18$; $SD = 6.52$ months) and 40 7- to 9-year-olds (18 males; $M_{age} = 101.59$ months; $SD = 9.74$ months), recruited and tested at local museums in Berlin. Participants belonged to various social classes and were native German or fluent in German. IRB approval was obtained and parents gave informed consent for their children

to participate before the study. Twenty-four additional participants were excluded from the analyses due to technical issues ($n = 2$) and for failing the attention ($n = 7$), the memory check ($n = 9$; see below), or both ($n = 6$; see below).

Design and procedure The design and procedure of Study 2 was identical to that of Study 1, with the following exceptions: First, the task (storybook and survey) was implemented on a 10" Tablet. Second, the familiarization story and the test questions were read to children by an experimenter, who also reminded them, at the end of each scenario, which monster was a good and which one was a bad question asker. Third, in the test phase, instead of being asked to provide a rating from 0 to 10 as in Study 1, children were asked, for each question, to select the monster they thought was more likely to possess/was better at the presented abilities/traits/characteristics. Two cards illustrating the monsters were used to help children indicate their preference. Finally, as an attention and memory check, we asked children both at the beginning and at the end of the test phase to indicate which monster was the best at asking questions.

Results

Children's selections were coded as "1" when they indicated the good question asker, or "0" when they indicated the bad question asker. Results are presented in 2. We performed a multivariate regression with adults' ratings in Study 1 as predictors of children's selections in Study 2. This analysis revealed that adults' ratings predicted 7- to 9-year-old children's response pattern ($\beta = .025$, $t(12) = 3.19$, $p = .01$; $R^2 = .455$, $F(1, 12) = 10.20$, $p = .01$), but not 5- and 6-year-olds' ($\beta = .018$, $t(12) = 1.65$, $p = .12$; $R^2 = .137$, $F(1, 12) = 2.75$, $p = .12$) nor 3- and 4-year-olds' ($\beta = .010$, $t(12) = .84$, $p = .41$; $R^2 = -.027$, $F(1, 12) = .716$, $p = .41$). We then performed a series of binomial tests to assess whether children's preference for the question asker on each ability/trait/characteristic differed from chance (50%). The results (see Table 2) show that the extent of children generalizations strongly varies between age groups. Generally, 3- to 4-year-olds' showed a very unsystematic response pattern: They had no preference for the good question asker for abilities, traits and characteristics that both adults and older children deemed related to question asking (e.g., "being good at school", "being good at treasure hunting"), but displayed a strong preference for some clearly irrelevant questions (e.g., "having siblings", "seeing the farthest"). Five- to 6-year-olds clearly overgeneralized: They extended question-asking competence to both related and unrelated domains, selecting the good question-assembler above chance for 10 of the 12 questions presented ("being good at school", "being clever", "being good at treasure hunting", "being fast at completing jigsaw puzzles", "knowing many animal names", "being friendly", "having siblings", "being good at playing soccer", "seeing the farthest", "liking ice cream"). However, 7- to 9-year-olds showed a systematic and meaningful attributions of relevant abilities/traits/characteristics to the good question-assembler, very

similar to the one found with adults in Study 1.

General Discussion

In this project we explored across two experiments to what extent adults (Study 1) and 3- to 9-year-old children (Study 2) generalize question-asking competence to other abilities/traits/characteristics. Taken together, our results suggest a clear developmental trend: Three- and 4-year-olds drew unsystematic inferences from the monsters question-asking expertise, showing no preference for the good question asker when evaluating abilities, traits and characteristics that both adults and older children deemed strongly related to question asking (e.g., "being good at school", "being good at treasure hunting"). At the same time, they showed a strong preference for the good question asker on some clearly irrelevant questions (e.g., "having siblings", "seeing the farthest"). Five- and 6-year-olds identified the good question asker as better/more likely to have nearly every presented ability/characteristic. Seven- to 9-year-olds showed adult-like response patterns, selectively associating question-asking competency to some, relevant abilities and characteristics (e.g., "being good at school" and "being clever"), but not to others (e.g., "kicking a ball the furthest", "seeing the farthest" and "liking ice cream").

Three- and 4-year-olds in our study failed to associate traits and abilities such as "being good at school" and "being good at treasure hunting" with question-asking expertise, an association rated strong by adults and older children. We should notice that these two characteristics might have been difficult to understand for children this age. On the one hand, they probably do not have yet a clear idea of what "being good at school" means, as they are not in school yet. On the other hand, they might not appreciate the strategic component underlying the ability of being good at treasure hunting. This component seems to be more evident for them in the ability of solving puzzles. Moreover, their preference response for "knowing many animal names" suggests that young children might consider semantic knowledge as connected to question asking and maybe, more generally, to active learning competence. This is in contrast to the results obtained by Fusaro and colleagues (2011) and Brosseau-Liard and Birch (2011). In their studies, 4-year-olds generalized behavior to traits (e.g. inferred that an accurate puppet would have been smart), but did not make any generalization from behavior to semantic knowledge (e.g., knowing animal habits; Fusaro, Corriveau, & Harris, 2011) or did not endorse the accurate puppets' testimony about situation-specific knowledge (e.g., knowing the content of a box; Brosseau-Liard & Birch, 2011).

Our results suggest that 5- and 6-year-olds considered effective question asking as an indicator of global rather than a domain- or ability-specific expertise and of general likability. This over-generalization trend is in line with some previous findings suggesting that children at this age tend to make broader generalizations when the informant possesses some

Table 2: Mean proportion of children who indicated the best question asker as more likely to possess each ability against chance (50%; binomial test) in Study 2.

Abilities/traits/characteristics	3-to 4-year-olds			5-to 6-year-olds			7-to 9-year-olds		
	Mean	CI	<i>p</i>	Mean	CI	<i>p</i>	Mean	CI	<i>p</i>
Being good at school	.60	.43 - .75	.20	.83	.67 - .92	<.001	.83	.67 - .92	<.001
Being clever	.68	.50 - .81	.03	.80	.64 - .90	<.001	.78	.61 - .89	.001
Being good at treasure hunting	.58	.48 - .73	.34	.65	.48 - .79	.05	.68	.50 - .81	.03
Being fast at completing puzzles	.68	.50 - .81	.03	.83	.67 - .93	<.001	.58	.40 - .73	.34
Knowing many animal names	.78	.61 - .89	<.01	.78	.61 - .89	<.001	.75	.58 - .87	<.01
Being friendly	.70	.53 - .83	.01	.93	.80 - .98	<.001	.73	.56 - .85	<.01
Having siblings	.73	.56 - .85	<.01	.65	.48 - .79	.05	.68	.50 - .81	.03
Being good at playing soccer	.45	.29 - .62	.52	.75	.59 - .87	<.01	.68	.50 - .81	.03
Seeing the farthest	.75	.58 - .86	<.01	.68	.50 - .81	.03	.63	.45 - .77	.11
Scoring lots of goals	.45	.29 - .62	.52	.55	.39 - .71	.52	.55	.38 - .70	.52
Kicking a ball the furthest	.60	.43 - .75	.20	.60	.43 - .75	.20	.55	.38 - .70	.52
Liking ice cream	.50	.33 - .66	1	.75	.58 - .87	<.01	.50	.33 - .66	1

kind of semantic knowledge (e.g., labels objects accurately, Brosseau-Liard & Birch, 2010; knows causal properties of an object, Sobel & Corriveau, 2010) and demonstrates socio-moral goodness (Cain, Heyman, & Walker, 1997). However, Bridgers and colleagues (2018) demonstrated that already at age 4, children selectively generalize active learning effectiveness only to tasks where this competence is deemed relevant. This apparent inconsistency might indicate that children have different intuitions and make different generalizations depending on the different *kinds* of active learning competency an agent display (e.g., physical exploration versus question asking), and this differential pattern might interact with age. It would be interesting to explore this question in future research.

The adult-like response pattern of 7- to 9-year old children, who selectively associated question-asking competence only to related abilities and traits, is in line with the few results from previous research focusing on this age group (e.g., Lane et al., 2013; Danovitch & Keil, 2004. For example, Danovitch and Keil (2007) presented 6, 8 and 9- year-olds with four short vignettes illustrating a character facing a moral dilemmas (e.g., respect another's privacy) or involved in a scientific problem (e.g., building a rocket). Following each vignette, participants were asked to choose what characteristics the character would have needed to solve the problem (e.g., "Does he need to be nice with other people" or "Does he need to be smart"). Their results showed that only starting at age 8 children consistently indicated that scientific skills were necessary to solve scientific problems and that moral characteristics were needed to solve moral dilemmas (Danovitch & Keil, 2007). Finally, it might be that to make selective, meaningful inferences about question asking, one has to be good at asking questions herself. In this respect, the developmental trend found in this study might be reflective of children's improvement in question-asking effectiveness. Future research should explore whether and how children's ability to ask in-

formative questions or search effectively more in general can impact the inferences and generalizations they make based on others' active learning competence. Moreover, it seems clear that even older children's responses did not always and perfectly reflect adults' intuitions. This difference could be resulting from the different ways in which participants were asked to elicit their intuitions in Study 1 and 2.

It is crucial to note that in our studies the good question asker was simply contrasted with a *bad* question asker, who was not given any other positive nor neutral attributes, whereas in many studies focusing on generalizations, including those reviewed above, informants are presented as experts in different domains (e.g., (Lutz & Keil, 2002; Kushnir et al., 2013; Jaswal et al., 2010; Koenig, 2012). We are currently finishing data collection on a follow up study in which we implement the more traditional version of paradigm, contrasting an agent who is good at asking questions and "finding out things" with one that has a domain-specific expertise (e.g., knows everything about fish). Future work should also investigate the impact of such inferences and generalizations on children's learning and social behavior, for example examining under which conditions children would prefer to imitate, learn or ask for help to someone they identify as an effective active learner.

To conclude, this study is a first attempt at exploring what children infer based on someone's ability to ask effective questions. We found an interesting developmental pattern from unsystematic generalization, to overgeneralization, to adults-like selective generalization, suggesting that children at different ages use information about an agent's active learning competence in different ways. This is a first step in understanding whether and how children use their sensitivity to others' active learning competence to navigate the social world, identifying good role models to learn, and to *learn how to learn* from.

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