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“Is it worth my time and effort?”: How children selectively gather information from experts when faced with different kinds of costs

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ABSTRACT

Gathering good-quality information is important for effective learning, but children may often need to expend time or energy (i.e., costs) in order to do so. In this study, we examined how 4- and 5-year-olds ($N = 91$) gather information from others when one source of information comes at a cost. Children were given three types of question cards (doctor-related, mechanic-related, and neutral questions) and could assign each question to either a doctor or car mechanic puppet. One puppet (either the doctor or the car mechanic, counterbalanced) could be accessed immediately, but the other puppet required either waiting 30 s or completing a tedious sorting task first. Children's verbal intelligence and executive function skills were also assessed. Results showed that cost influenced how children sought information from each of the expert puppets; children selected the costly expert for domain-relevant questions at chance levels and otherwise strongly preferred to question the non-costly puppet. In addition, executive function skills (but not verbal intelligence) related to how frequently children were willing to direct questions to the costly puppet. Overall, these results indicate that children are influenced by costs when gathering information from others and that their ability to expend a cost to gather good-quality information may relate to their inhibition skills. Implications for encouraging effective learning are discussed.

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Introduction

By the time children are 4 or 5 years old, they understand that different people may know different things. For instance, 4-year-olds have a sense of what familiar experts are likely to know; they attribute knowledge about cars to a car mechanic and knowledge about animals to an animal expert (Lane & Harris, 2015; Lutz & Keil, 2002). In addition, they recognize that there is specificity to expertise; for example, a dog expert does not know more about unrelated objects than someone who is not a dog expert (Koenig & Jaswal, 2011). Although children's sense of the breadth and scope of expertise certainly improves throughout development (e.g., Keil, Stein, Webb, Billings, & Rozenblit, 2008; Landrum & Mills, 2015), even young children can use information about what someone is likely to know to guide their questioning behavior and their acceptance of new information (see also Harris & Corriveau, 2011; Mills, 2013; Sobel & Kushnir, 2013). That said, just because preschool children *can* demonstrate selectivity when gathering information does not mean that they always do so. For instance, in some cases children's information seeking may be guided by social goals (Jaswal & Kondrad, 2016) such as a desire to affiliate with people who seem friendly even if they seem less knowledgeable (Rowles & Mills, 2018).

Here, we proposed that another factor will influence children's willingness to gather information from high-quality sources of information: the cost of gathering that information. As children gather information from others, they may encounter situational or environmental factors that need to be overcome to reach a goal. For instance, a child who wants to ask a competent adult for information may need to wait until the adult is finished with another task or to finish some chores first. Children must determine whether the cost is too high (or the benefit is too low) to make going to a quality source worthwhile.

To our knowledge, only one set of studies has examined whether children's ability to exhibit selective trust can be affected by costs. In research conducted by Brosseau-Liard (2014), children were sometimes asked to pay stickers to gather information from a more desirable source. In one experiment, 4- to 7-year-olds initially watched a puppet label familiar objects accurately and then underwent test trials where they could gather information about the names of objects or rules for playing with objects from a computer labeled as "always right" and the puppet labeled as "may be right or may be wrong." In a no-cost condition, children could gather information from the computer or puppet at equal rates. In a cost condition, children could freely go to the puppet but needed to pay a sticker to gather information from the computer. In the no-cost condition, children directed questions to the computer at high rates, but in the cost condition, when the computer was costly, children were far less likely to direct questions to the computer. In other words, children in this study were deterred by the payment-based cost.

Although adults frequently encounter payment-based costs in everyday life, preschool-aged children may be more likely to encounter other forms of costs when gathering information. Take, for instance, the cost of time. Children might need to wait until an adult is available to ask a question and receive a response. Preschool-age children can sometimes show patience when encountering time as a barrier to some sort of reward. For instance, in classic studies examining the ability to delay gratification, some preschool-age children were willing to wait a while to receive a tangible treat, such as multiple marshmallows or cookies, instead of accepting a less preferable outcome immediately, such as only one marshmallow or cookie (Mischel, Ebbesen, & Raskoff Zeiss, 1972; see also Mischel, 2014). It is possible that in some cases children may be willing to wait patiently to gather good information (i.e. the "reward") instead of settling for inadequate information.

Another cost to information gathering may be effort. For instance, a child may need to go all the way upstairs to ask a knowledgeable adult a question instead of, say, asking a peer located in the same room. Or a child might be asked to do something else, such as a chore, until a parent is available to discuss a question (e.g., "I can't answer your question right now, but put up the dishes while I finish your lunches for tomorrow and we can talk about it afterward"). On the one hand, having an effortful task to complete while waiting for something else may make that waiting process easier to handle; indeed, in traditional delay of gratification tasks, providing children with suggestions on how to

distract themselves—that is, some sort of effortful task—while waiting for a reward can help them to be more patient (e.g., [Peake, Hebl, & Mischel, 2002](#)). On the other hand, sometimes the cost of expending the effort might not be seen as worth the benefits of being patient and getting that final reward.

In thinking through how children might respond to costs to gather information from appropriate sources, it is worthwhile to note that there are likely to be individual differences; after all, there are significant individual differences in willingness to wait for a tangible reward that relate to long-term developmental outcomes (e.g., [Mischel, Shoda, & Peake, 1988](#)). When children use questions to gather information from others (i.e., engage in *inquiry*), success can depend on a number of different factors based on what is challenging for that particular task ([Butler, Ronfard, & Corriveau, 2019](#); [Ronfard, Zambrana, Hermansen, & Kelemen, 2018](#)). In some cases the biggest challenge is articulating a good-quality question, in other cases the biggest challenge is determining which expert might best answer a question, and in still other cases the biggest challenge is being patient enough to push through the obstacles needed to gather the desired information. The factors that contribute to individual differences in inquiry may depend on which step or steps are most challenging for a particular task and which skill(s) of a child's skill set are taxed ([Butler et al., 2019](#); [Ronfard et al., 2018](#)). But surprisingly few studies examining inquiry to date also have explored possible reasons for individual difference in performance, and so there is much to learn.

In the age of “fake news,” where a plethora of information varying drastically in quality is available at one's fingertips, understanding how children approach gathering good-quality information—even in the face of obstacles—is an important issue. Systematic research understanding how children approach gathering information from others is crucial in order to understand how to help children effectively learn from others. How do different types of costs influence how children gather information from others? And what characteristics might help children be better able to endure a cost when gathering information? To begin to address these issues, the research presented here focused on examining how children direct questions to familiar experts when the relevant information sometimes comes at the cost of either time or effort.

Prior research has demonstrated that 4- and 5-year-olds understand that different people know different things, and in some cases they can ask questions and attribute knowledge to familiar experts ([Aguilar, Stoess, & Taylor, 2012](#); [Lane & Harris, 2015](#); [Lutz & Keil, 2002](#)). Building on this research, we created a task in which children were introduced to a doctor puppet and a mechanic puppet (experts found to be familiar with preschool-aged children; see [Lutz & Keil, 2002](#)). Children were then given a set of doctor-related, mechanic-related, and neutral (i.e., political science-related) questions to assign one by one to the experts. Importantly, the experts were not equally accessible; children could assign a question to one of the experts immediately but would need to pay a cost to assign a question to the other expert. The knowledge from the “costly expert” could be obtained only after waiting 30 s (i.e., timed delay condition) or after completing a mundane but effortful task of approximately the same length of time (i.e., effortful delay condition).

For the main task, we had two primary hypotheses. First, we hypothesized that cost would influence how children seek out information from experts. When there were no costs involved, we expected that children would be more likely to select the relevant expert for questions relating to that particular domain (e.g., selecting the doctor for questions about medicine). When costs were involved, however, we hypothesized that children's selections of the relevant—but costly—expert would decrease. In addition, although we hypothesized that children would be deterred by costs in general, we thought that the degree to which they were deterred might differ based on the type of cost. More specifically, we speculated that children might be more likely to expend an effortful delay cost than a timed delay cost because having an activity to complete might make the delay more manageable than simply waiting.

Second, although we expected that children would tend to favor the non-costly source overall, we anticipated that there would be individual differences underlying children's selections of different experts when there was a cost present. We thought that two particular aspects of the inquiry process involved here could challenge young children and lead to individual differences in performance: reflecting on whether it is worthwhile to direct a question to a specific source and deciding what kind of information might help to answer a question. To decide whether it is worthwhile to direct a question to a specific source, children may need to inhibit their default response to trust all others so as to

recognize that different sources may be helpful for different questions. And some children may be better than others at overriding their default response to trust others. Indeed, prior research suggests that executive function—and in particular inhibitory control—relates to 2.5- to 3.5-year-olds' ability to inhibit their response to trust others when provided with misleading information (Jaswal et al., 2014). Thus, we thought that executive function skills might relate to children's ability to inhibit their response to immediately go to an irrelevant source and instead wait to gather information from a more relevant source.

In deciding what kind of information might help to answer a question, children need to think about the content of a particular question and whether a particular kind of expertise would be needed to address that question. Here, there is some evidence that verbal intelligence plays a role in how children think through the content and quality of questions and explanations (e.g., Mills, Danovitch, Rowles, & Campbell, 2017; Mills & Elashi, 2014). It is possible that verbal intelligence could help children to better dissect a given question and recognize what kind of expertise would be most useful. That said, for this particular task, we speculated that verbal intelligence might not be as important as executive function skills for performance; the task was specifically chosen because children in this age range have demonstrated the ability to recognize which of these familiar experts knows answers to different questions like these, and the challenge was designed to involve willingness to thoughtfully gather information. But we measured both executive function skills and verbal intelligence to examine whether our prediction was supported.

Method

Participants

A total of 91 typically developing children aged 4 or 5 years ($M = 4.89$ years, $SD = 0.42$; 48% male and 52% female) participated in this study after being recruited from and tested at preschools in the Richardson, Plano, and North Dallas areas of Texas. To determine an appropriate sample size, we reviewed past research examining individual differences in selective trust. Such articles rarely report effect sizes, but of the ones that do or that provide enough information to calculate them externally, the effect sizes seem to be moderate, between .30 and .60 (see DiYanni, Nini, Rheel, & Livelli, 2012; Heyman, Sritanyaratana, & Vanderbilt, 2013; Jaswal et al., 2014). However, many of the dependent variables and statistical analyses in these studies vary; thus, it is difficult to get an accurate estimate of what to expect in the current study. To explore how to move forward, we conducted two power analyses with G*Power 3.1. First, we conducted a power analysis for a repeated-measures analysis of variance (ANOVA) for the possibility of a within (item type) by between (cost type) interaction. Assuming a moderate effect size of .25, a sample size of 44 was recommended. Second, we also conducted a power analysis for linear regression; assuming a moderate effect size of .15, a total sample size of 74 was recommended. We chose to target a larger sample size of at least 84 total (42 per condition).

Materials

Primary materials included a doctor puppet and a car mechanic puppet. A stage was created with a curtain that could be moved in front of and in back of the puppets to reset the stage after each trial (see Fig. 1). A video camera and tripod were used to record each session. Both the timed delay and effortful delay conditions also required two small boxes, two Bluetooth padlocks, question cards, and stickers. For the effortful delay, black, brown, and tan marble-sized pom pom balls, as well as corresponding colored cups for sorting, were needed.

For the individual difference measures, an iPad Air 2 was used to administer the NIH (National Institutes of Health) Toolbox Picture Vocabulary Test (Gershon et al., 2013). A set of 16 cards were used for the Day/Night task, with 8 cards having a picture of the sun and 8 cards having a picture of the moon.



Fig. 1. Photograph of how the setup was presented to each child.

Measures

Questions were developed targeting either the doctor's expertise (related to medicine and health), the mechanic's expertise (related to vehicles), or expertise that neither expert clearly held (related to political science) (see Appendix for all items). The doctor and mechanic questions were adapted from previous research (Aguiar et al., 2012; Lutz & Keil, 2002). Neutral questions were developed to be in a domain of knowledge (i.e., political science) for which neither the doctor nor the mechanic seemed like a better expert to answer the questions. These questions were piloted with adults, finding that adults had no preference between selecting the doctor or mechanic to answer each of the questions and that, when forced to choose one, the selection pattern overall was random. All items were then piloted with 8 children in a simple version of the paradigm for which children could assign questions without any costs involved. For domain-relevant questions (e.g., doctor-related questions for the doctor, mechanic-related questions for the mechanic), children chose the correct expert more than 90% of the time. For the neutral questions, children did not show a preference between the two experts. Combining these findings with findings from past research, we felt comfortable in concluding that children in this age range generally knew which question to assign which expert for the domain-relevant items and did not have a strong preference for one expert over the other for the neutral domain items.

All other measures completed by the children during the testing session are described in the "Procedure" section below.

In addition, parents and teachers completed the 33-item inhibition and working memory subscales of the Behavioral Rating Inventory of Executive Function–Preschool version (BRIEF-P; Gioia, Espy, & Isquith, 2003). Each item provides a behavior, and the parent and teacher were instructed to respond with how often that behavior is a problem for the child (*never*, *sometimes*, or *often*). Scores for each item ranged from 0 to 2 (with 0 indicating that the child never had a problem with that behavior), with

a possible range of scores between 0 and 66 (higher scores indicated more behavior problems). Research has found that ratings on the inhibition and working memory subscales of the BRIEF-P have been found to predict scores on performance-based inhibition and simple working memory measures, respectively (Garon, Piccinin, & Smith, 2016). We chose to include these measures to gain a more comprehensive perspective on children's executive function skills.

Procedure

Consent forms were distributed through the preschools, and each form included the inhibition and working memory subscales of the BRIEF-P. Once all the consent forms were collected, each teacher was given the BRIEF-P subscales for each child whose parent consented. Each child was pulled out of class one at a time into a quiet room for testing. Each testing session had one main experimenter interacting with the child and one research assistant to help the testing procedure run smoothly. If the parent consented to the child being videotaped, a video camera was turned on at the beginning of the session as a backup for data collection. During all phases of testing, the experimenter kept track of the child's responses on a hard-copy testing sheet. If any data were missed during testing, the experimenter would review the videotape to determine the correct scoring. If the parent did not consent to the child being videotaped, both the experimenter and research assistant would separately record the data on hard-copy testing sheets to increase the likelihood that all data would be correctly collected. There were no disagreements in scoring for children who were not videotaped.

Training phase

Children were introduced to a doctor puppet and a car mechanic puppet and were told information about what the puppets know (e.g., "This is Doctor Jones. He knows all about the human body and takes care of people who are sick or hurt"; adapted from Aguiar et al., 2012). These professions were selected because previous research has found that children in this age range are able to correctly attribute domain-related knowledge to each expert (Lutz & Keil, 2002). To further solidify what each expert knows, the experimenter asked the two puppets two questions to demonstrate each puppet's knowledge. For example, when asked a question about the body ("Where are the smallest bones in your body?"), the doctor provided a correct answer ("In your ear") and the car mechanic said "I don't know." The opposite was true for questions related to cars ("How do brakes make a car stop?"), with the car mechanic providing a correct answer ("Pressing the brakes squeezes the tire, which makes the car stop") and the doctor saying "I don't know."

Test phase

Children were told that they would hear different questions and needed to choose one of the two puppets to answer each question by placing the question card in a box in front of the selected puppet. Children were told that after all the questions were assigned, the puppets would answer the questions that were assigned to them. In this way, children would not receive feedback on how the puppets answered the questions throughout; only after all questions had been assigned would children see how the puppets answered the questions. Children were told, "You can pick up the question card at any time and place it in whichever puppet's box you want to answer the question." They were also told that at the end of the game, for every question the puppets got correct, children would receive a sticker to take home with them.

Children were then shown how to use the boxes to assign the cards. Children were told that each box had a lock on it. In the timed delay condition, children were told that after the question was read, the locks would open at different times; one of the locks would open immediately (for the non-costly puppet), and the other lock would open after 30 s (for the costly puppet) (for the costly puppet; whether the doctor or mechanic was costly was counterbalanced between participants for both conditions). Thus, children needed to wait 30 s before they could place a question card in the costly puppet's box (e.g., the mechanic's box when the mechanic was costly), or they could place the question card in the other puppet's box immediately. Piloting confirmed that 30 s seemed appropriate while still showing variability in children's performance.

In the effortful delay condition, in order to place a card in the costly puppet's question box, children needed to sort 30 black, brown, and tan pom pom balls into their corresponding colored cups (based on the non-engaging task in [Peake et al., 2002](#)). A total of 30 pom pom balls was chosen after piloting because it took children between 30 and 45 s on average to sort them, mirroring the 30-s wait time. The mixed-up pom poms were in a tray in front of the sorting cups, and this was placed in front of the costly puppet. After children heard a question, they could choose whether they wanted to (a) sort the pom poms, which opened the lock to the costly puppet's box, or (b) place the question card in the non-costly puppet's box without needing to begin or complete the sorting task. If children chose to sort the pom poms, once the last pom pom was correctly sorted, the padlock unlocked (controlled by the research assistant with a Bluetooth-compatible device) and children were then able to place the card in the costly puppet's question box. During both conditions, the experimenter sat quietly after reading each question card to the child.

For the addition of the cost to not seem arbitrary, each puppet's box had a Bluetooth padlock on the front that could be unlocked out of sight with an iPhone. A timer was placed on the table so that children could keep track of how much time had passed. Thus, either children could choose to wait 30 s/-complete the sorting task until the costly puppet's padlock unlocked to place a card in that box or they could pick up the card at any time and place it in the immediately opened non-costly puppet's box (see [Fig. 2](#) for a diagram of the event sequence). Importantly, because there were different question domains (i.e., doctor, mechanic, and neutral domains), one puppet being costly did not indicate that it was the "right" choice because that would be true only for that puppet's relevant domain questions. Children were not given explicit instructions regarding how often they should select each puppet or how they should decide whether or not to wait to assign a question.

Children heard 12 questions: 4 doctor-related questions, 4 mechanic-related questions, and 4 neutral questions related to neither domain of expertise (i.e., political science-related questions). Between each question, the puppets were slid behind a curtain so that a research assistant could relock the padlocks out of children's sight. After all the questions were assigned, the puppets then answered the questions that were assigned to them. If children selected the correct puppet for a question (e.g., the doctor for a doctor-related question), the puppet answered the question correctly at the end and children received a sticker. If children selected the incorrect puppet for a question, the puppet responded with "I don't know" and children did not receive a sticker.

Posttest phase

Children were then asked posttest questions. First, children heard two posttest explicit judgment questions to see whether they remembered which puppet was costly and which puppet was not costly. They then answered follow-up questions regarding whether they thought each of the puppets was smart and strong (e.g., "Do you think doctors are smart? Strong?", "Do you think car mechanics are smart? Strong?"). The goal was for these questions to provide insight into how children viewed the experts beyond what could be inferred by their behavior during the procedure alone.

Finally, children were asked a question to determine how they perceived the rules of the game (i.e., "The two puppets had different boxes with different locks. Do you think they were different because that was just the rules of the game or because of something else?"). If children selected "something else," then they were asked to provide an explanation. We coded their responses to determine whether children perceived that there were differences in the boxes due to the characteristics of the experts (e.g., the costly expert being more mean than the other expert and not wanting to share his information).

Individual difference measures

Children then completed four individual difference measures: the NIH Toolbox Picture Vocabulary Test (TPVT), Day/Night task, Forward Digit Span, and Head-Toes-Knees-Shoulders task.

The TPVT ([Gershon et al., 2013](#)) is a measure of children's verbal intelligence. Children accessed the TPVT via the NIH Toolbox on an iPad 2. They saw sets of four images and heard audio of a word that described one of the four pictures. Children needed to select the picture that they thought corresponded most closely with the word they heard. After selecting a picture, children moved on to the next set of pictures. The NIH Toolbox uses computer adaptive testing, meaning that which picture

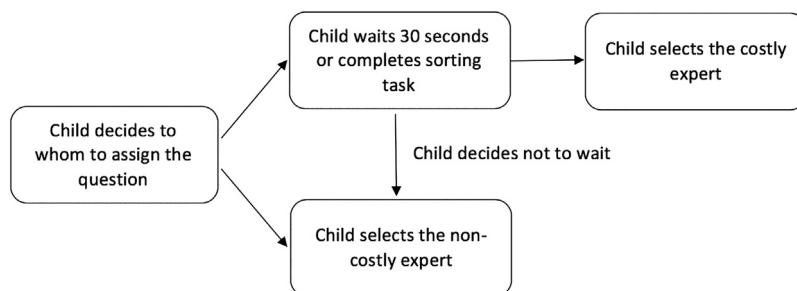


Fig. 2. Diagram of the sequence of events during the testing phase.

set children received next depended on their performance on previous items. The NIH Toolbox provides an age-corrected standard score, which compares each child's vocabulary with that of other similarly aged children ($M = 100$, $SD = 15$). Similar tests have been related to children's ability to evaluate other's claims (Mills & Elashi, 2014; Mills et al., 2017).

The Day/Night task is a measure of inhibitory control (executive function component; Gerstadt, Hong, & Diamond, 1994). The Day/Night task has been related to children's academic performance (McClelland et al., 2014), suggestibility (Alexander et al., 2002; Karpinski & Scullin, 2009), theory of mind (Carlson & Moses, 2001), and more sophisticated lie-telling (Evans, Xu, & Lee, 2011). Children were shown pictures of the sun and the moon and were instructed to say the word "day" when they saw the picture of the moon and to say "night" when they saw the picture of the sun. Children began with two training trials, where they saw both a sun card and a moon card and received corrective feedback if needed. They then completed 16 test trials with no feedback for a total possible 16 points.

Forward Digit Span is a measure of working memory (executive function component; Wechsler, 1949).¹ Children heard strings of numbers and needed to repeat them back. Children were given two practice trials of two-digit sequences (e.g., 5–8) and then completed test trials beginning with two digits and increasing by one up to seven digits. Each digit length had two test trials (e.g., two different five-digit sequences). Children received 1 point for each correct sequence, and testing ended once children incorrectly repeated two sequences with the same digit length. Children's scores could range from 0 to 14. Forward Digit Span is related to children's academic performance (Bull, Espy, & Wiebe, 2008; Rasmussen & Bisanz, 2005) and source monitoring accuracy (Earhart & Roberts, 2014) and has been shown to have variability within the 4- and 5-year age range (Carlson, 2005).

Finally, the Head-Toes-Knees-Shoulders task (HTKS; Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; McClelland et al., 2007) is primarily a measure of inhibitory control but also involves children's working memory and attention. The HTKS task was selected because research has shown that it is sensitive to differences within the 4- and 5-year age range (Cameron Ponitz et al., 2009; Lan, Legare, Ponitz, Li, & Morrison, 2011; see McClelland & Cameron, 2012) and has been related to outcomes such as academic achievement (Cameron et al., 2012; Cameron Ponitz et al., 2009; Lan et al., 2011). Part 1 included 10 test trials, where children were told the commands "touch your head" and "touch your toes" and were instructed to do the opposite (i.e., touch their toes and head, respectively). Children received 2 points if they touched the correct body part, 1 point if they self-corrected (motioned toward spoken body part and then touched correct one), and 0 points if they touched the incorrect body part. For Part 1, scores could range from 0 to 20 points. If children received at least 4 points in Part 1, they moved on to Part 2. Part 2 was identical to Part 1 except that the commands "touch your shoulders" and "touch your knees" were added in with the other two commands. Although the HTKS task sometimes includes one additional part, we chose to use the two-part version

¹ We note that some researchers argue that the Forward Digit Span is more accurately described as a measure of verbal short-term memory (see Alloway, Gathercole, & Pickering, 2006).

for three reasons. First, we predominantly saw the two-part version being used for children in this age range (e.g., Cameron et al., 2012; Cameron Ponitz et al., 2009; Lan et al., 2011). Second, we were getting significant variability with the two-part version within our sample during piloting. Third, our testing sessions were already quite long. Between Part 1 and Part 2, children had the possibility of scoring between 0 and 40 points.

Results

Preliminary analysis

After completing the main task, children were asked two posttest explicit judgment questions to see whether they remembered which puppet was costly and which one was not costly, and 74 children (81.3%) were accurate on both questions. In contrast, 17 children (18.7%) missed one or both of those questions. Examining these two groups on the individual difference measures (TPVT, HTKS, Forward Digit Span, and Day/Night), we found only one significant difference between the groups, namely that children who were accurate on both posttest questions scored significantly higher on the TPVT than children who were not ($M = 110.06$, $SD = 12.49$ and $M = 100.73$, $SD = 10.86$, respectively).

Subsequent analyses focus on only the children who passed both posttest questions as a conservative approach to examine how children who clearly understood which expert was costly and which one was not approached directing questions to the puppets ($n = 74$). That said, note that the findings do not change significantly when all children are included.

Before beginning our primary analyses, we also checked whether there were differences in performance based on which puppet was costly (the doctor for half the children and the mechanic for the other half). We first determined the number of times children selected the relevant costly expert (e.g., selecting the doctor for the doctor-related questions; four items total). We compared how frequently children selected the relevant costly expert when the expert was a doctor with when the expert was a mechanic, finding no differences, $t(72) = 0.004$, $p = 1.00$, $d = 0.00$. Thus, all subsequent analyses were collapsed across the domain of expertise to focus on how children assign questions depending on which domain of knowledge a question targeted (domain-relevant, domain-irrelevant, or domain-neutral) and which expert children chose (costly or non-costly). In these analyses, a question would be considered in the costly domain if it was relevant to the costly expert's domain of knowledge (e.g., doctor-related questions when the doctor puppet was costly, mechanic-related questions when the mechanic puppet was costly), in the non-costly domain if it was relevant to the non-costly expert's domain of knowledge (e.g., mechanic-related questions when the doctor puppet was costly; doctor-related questions when the mechanic puppet was costly), and in the neutral domain if it was not relevant to either expert's domain of knowledge (always political science-related questions).

Main task performance

Our first set of analyses examined whether there were differences in how frequently children selected the costly puppet based on the question domain and/or the type of cost.

Inspection of Fig. 3 supports that children rarely assigned questions to the costly expert, but there appeared to be domain differences. To examine these data, we first conducted a repeated-measures ANOVA with item type (non-costly domain, neutral domain, or costly domain) as a within-participants variable, cost type (timed delay or effortful delay) as a between-participants variable, and number of selections of the costly expert as the dependent variable. Because Mauchly's test of sphericity had been violated, $\chi^2(2) = 9.00$, $p = .01$, we used the Greenhouse–Geisser correction. Overall, we found no main effect of the type of cost, $F(1, 72) = 0.49$, $p = .49$, partial $\eta^2 = .007$, and did not find an interaction between the type of cost and the type of item, $F(1.79, 128.69) = 1.09$, $p = .33$, partial $\eta^2 = .015$. Instead, children's selections of the costly expert differed by item type, $F(1.79, 128.69) = 19.71$, $p < .001$, partial $\eta^2 = .215$. Planned contrasts support that children

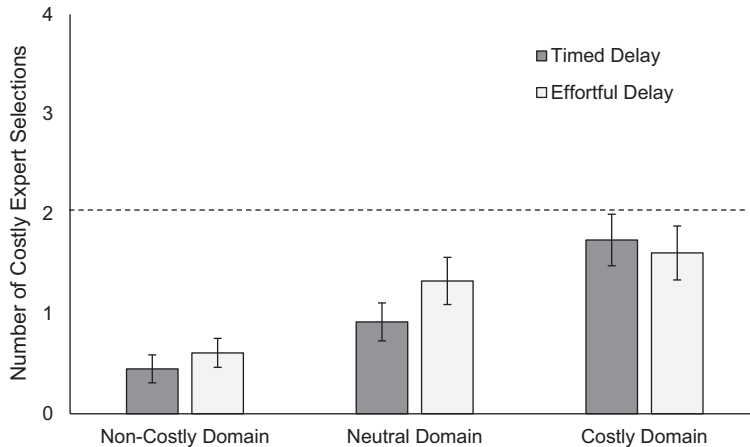


Fig. 3. Number of selections of the costly expert (out of 4 possible) for questions from the non-costly domain, neutral domain, and costly domain. Error bars indicate standard errors.

chose the costly expert most often for the costly domain ($M = 1.68$ of 4, $SD = 1.60$), next most often for the neutral domain ($M = 1.12$, $SD = 1.30$), and least often for the non-costly domain ($M = 0.53$, $SD = 0.86$), all $ps < .01$.

Our next set of analyses focused on *accuracy*, that is, how often children selected the *relevant* expert, regardless of cost, for each domain against chance performance. When the relevant expert was non-costly, children selected the appropriate expert (i.e., the non-costly one) at above-chance levels, $t(73) = 12.63$, $p < .001$, $d = 1.46$. Thus, children recognized that they should give questions to the expert that did not come at a cost when that was appropriate. For the questions in which either expert could (theoretically) be appropriate (i.e., the neutral questions, which were specifically created to not have a relevant expert), children preferred to assign questions to the puppet that did not come at a cost, $t(73) = 5.80$, $p < .001$, $d = 0.68$. Crucially, children performed differently when the relevant expert was costly; they performed at rates no different from chance (if anything, they trended toward choosing the *non-costly* expert), $t(73) = 1.75$, $p = .09$, $d = 0.20$. Together, these results support that children were deterred by the addition of cost given that they performed worse at assigning questions to the most domain-relevant expert when that expert required a cost to access than when he did not.

Because we initially predicted that children might seek out information from the costly expert differently depending on the type of cost, we conducted a post hoc test to see whether there were any differences in how often children chose the costly expert for costly domain items depending on the type of cost (i.e., timed delay or effortful delay). There were no differences, $t(72) = 0.34$, $p = .74$.

That said, there was significant variability in how children approached the task. Some children seemed to be particularly deterred by the idea of cost; indeed, 18 of the 74 children did not *ever* select the costly puppet for information. In contrast, 14 of the children *always* gave the costly puppet its related domain questions (although 1 of those children gave the costly puppet almost *every* question). Other children seemed to lie somewhere in the middle, selecting the costly puppet a few times and deferring to the non-costly puppet for the rest of the questions.

It is possible that children might have been willing to expend the cost at first but decided that doing so was not worth the effort later in the task. To examine this, we conducted a repeated-measures ANOVA comparing how often children chose the costly expert for the first half of the trials with the second half for the two types of costs (timed delay and effortful delay). We found no significant effect of timing or any interactions (all F s < 1.60 , $ps > .21$). Thus, children did not appear to drastically shift in their frequency of selecting the costly expert throughout the experiment.

Posttest questions

We analyzed whether children thought that doctors and car mechanics were either smart or not smart and whether they were strong or not strong. A McNemar's test indicated that there was no difference for children's ratings of smartness and strength between doctors and car mechanics, $ps > .29$. Doctors and car mechanics were assessed as similarly smart and strong regardless of which expert was costly ($ps > .37$).

Children were also asked whether they thought that the puppets had different boxes with different locks because "that was just the rules of the game or because of something else." Nearly half (47%) of children said that it was because of the rules of the game. Of the children who said something else, the majority referred to the rules of the game in some way (e.g., "because one opened immediately," "because one was slow and one was fast," "because this one opens when you sort the pom poms") or said "I don't know." No child provided an explanation that described one expert as more nice or helpful (or mean or unhelpful) than the other expert, and no child referred to the possibility that the experts were controlling the boxes in some way. Thus, children appeared to accept that the boxes had locks that differed in how they opened without connecting those differences to characteristics of the experts.

Individual difference measures

To measure the second hypothesis looking at the impact of verbal intelligence, working memory, and inhibitory control on children's expert selections, we then turned to the individual difference measures. We first looked at children's performance on each of the individual difference measures (TPVT, HTKS, Forward Digit Span, Day/Night, and the total BRIEF-P for the parent and teacher). For the TPVT, we used the age-corrected standard score, which represents each child's vocabulary level as compared with the average for other children of that age ($M = 100$, $SD = 15$). Children in this sample performed significantly higher than the population mean of 100 ($M = 110.06$, $SD = 12.49$), $t(68) = 6.69$, $p < .001$, $d = 0.80$. Overall, the individual difference measures had a great deal of variability. For descriptive information about these measures, see [Table 1](#).

We then wanted to assess whether verbal intelligence, working memory, and inhibition related to children's willingness to choose the costly expert when he was the appropriate source (i.e., for the costly domain questions). Thus, we ran correlations between the number of times (out of 4) children selected the relevant costly expert, children's age, TPVT scores, HTKS scores, Day/Night scores, Forward Digit Span scores, and the parent and teacher reports for the BRIEF-P. We found that children's selections of the relevant costly expert were correlated with children's HTKS and Day/Night scores ($rs > .24$, $ps < .05$) but not their TPVT scores ($r = .08$). Indeed, no other measures related to how frequently children selected the costly expert when he was relevant. For instance, parent and teacher BRIEF-P scores did not correlate with main task performance (or with each other). See [Table 2](#) for all correlations between the individual difference measures.

To further explore the relationship between the individual difference measures and children's performance on the main task, we then used regression to assess whether the correlated individual difference measures (HTKS and Day/Night) predicted children's selections of the relevant costly expert. We found that the overall model including standardized scores for both HTKS and Day/Night significantly predicted children's selections, $F(2, 71) = 3.78$, $p = .03$, $R^2 = .10$. When looking at the predictors, HTKS ($\beta = .22$, $p = .08$) and Day/Night ($\beta = .14$, $p = .26$) were not individually significantly predictive. Thus, the better children's performance was on both the HTKS and Day/Night tasks, the more likely they were to select the relevant costly expert. In this way, it seems as if the behavioral measures of executive function played a role in how often children selected the relevant costly expert.

As mentioned before, children approached this task in different ways, and one approach was of particular interest to us. Some children *never* assigned a question to the costly puppet, seeming to find the cost of waiting for the box to open just too high for them to fathom ($n = 18$ of 74). We examined whether these children differed on our individual difference measures (age, TPVT, HTKS, Day/Night, Forward Digit Span, and parent and teacher BRIEF-P). Compared with children who assigned a

Table 1

Descriptive statistics.

	N	M (SD)	Possible range
TPVT score	69	110.06 (12.49)	
HTKS task score	74	21.96 (12.16)	0–40
Day/Night task score	72	9.93 (4.52)	0–16
Forward Digit Span score	70	5.96 (1.63)	0–14
Teacher BRIEF-P	74	14.42 (14.21)	0–66
Parent BRIEF-P	66	19.23 (10.86)	0–66
Combined parent and teacher BRIEF-P	66	34.38 (19.84)	0–132

Note. TPVT, NIH Toolbox Picture Vocabulary Test; HTKS, Head–Toes–Knees–Shoulders; BRIEF-P, Behavioral Rating Inventory of Executive Function–Preschool version.

Table 2

Correlations.

		1	2	3	4	5	6	7	8
1. Age	<i>r</i>	1							
	<i>N</i>	74							
2. Total selections of relevant costly expert (out of 4)	<i>r</i>	.134	1						
	<i>N</i>	74	74						
3. TPVT score	<i>r</i>	–.046	.082	1					
	<i>N</i>	69	69	69					
4. HTKS task score	<i>r</i>	.342**	.283 [†]	.220 [†]	1				
	<i>N</i>	74	74	69	74				
5. Day/Night task score	<i>r</i>	.120	.236 [†]	.023	.418**	1			
	<i>N</i>	72	72	67	72	72			
6. Forward Digit Span score	<i>r</i>	.164	–.093	.073	.268*	.198	1		
	<i>N</i>	70	70	65	70	68	70		
7. Parent BRIEF-P overall	<i>r</i>	–.203	.095	–.219 [†]	–.113	–.082	–.192	1	
	<i>N</i>	65	65	62	65	63	62	65	
8. Teacher BRIEF-P overall	<i>r</i>	–.190	–.085	–.220 [†]	–.400**	–.219 [†]	–.107	.195	1
	<i>N</i>	74	74	69	74	72	70	65	74

[†] Correlation trends toward significance at the .10 level (two-tailed).

* Correlation is significant at the .05 level (two-tailed).

** Correlation is significant at the .01 level (two-tailed).

question to the costly expert at least once, children who *never* assigned a question to the costly expert had lower HTKS scores, $t(72) = -2.47$, $p = .016$, $d = 0.66$, and lower Day/Night scores, $t(70) = -2.34$, $p = .022$, $d = 0.62$. Thus, children with worse performance on the behavioral executive function measures were more likely to *never* give a question to the costly expert. Overall, these patterns of data provide additional evidence that executive function skills—and in particular inhibitory control skills—play a role in children's willingness to pay a cost to gather information.

Discussion

Children cannot always obtain quality information from others without some sort of cost. When in preschool, a teacher may be busy interacting with another student and might not be available to answer a question immediately, or a child may be asked to attempt to complete something first on his or her own before asking the teacher for help. In these cases, children will need to decide whether to wait or put effort into completing the task before they can gather information. Thus, the current study was conducted to help us understand how preschool children respond overall in the face of different kinds of costs. We examined how children sought information when faced with two kinds of costs—a delay based on time and a delay based on effort—and explored the role that individual differences might play in regard to reacting to these costs.

In a perfect world, children would always direct questions to others based on their relevant expertise regardless of cost. In practice, we found that the way children assigned questions to others depended on the domain of the question and whether or not gathering information came at a cost. As expected, for non-costly domain and neutral domain questions, children clearly favored questioning the expert who did not come at a cost. In contrast, for the costly domain questions, children wavered between the experts, choosing the appropriate expert at around chance levels. Put another way, if the mechanic was free and the doctor was costly, the children generally preferred to direct questions toward the non-costly mechanic, choosing the costly doctor only slightly more often (but still at chance levels) for questions in his domain (i.e., doctor-related). Thus, on the one hand, children appeared to be sensitive to the fact that the costly expert was sometimes the right expert for a problem, and they selected him more often when he was the right expert than when he was not. On the other hand, children still often chose to direct questions to the wrong expert, seeming unwilling to regularly spend the cost needed to gather accurate information.

So, are children affected by the *type* of cost when deciding whether or not they are willing to expend it? Although we thought it possible that doing a mundane task might be easier for children to handle than waiting with no distraction for 30 s, we saw no evidence of this; children performed similarly in both conditions. Still, it is important to note that these two costly tasks were designed to take approximately the same amount of time and to be short enough to be reasonable for young children to handle multiple times in a testing situation. We speculate that in other circumstances, such as with longer delays, completing a mundane task would be preferable to just waiting. Of course, the nature of the mundane task could also influence children's willingness to complete it. Some tasks may be seen as so tedious that children would prefer to wait in silence than complete a task before gathering information; other tasks may be seen as so integral to information gathering (e.g., searching through various websites in order to find the most accurate one) that they are hardly viewed as a cost at all. These are questions for future research.

This connects to the next central question of this research: What explains individual differences in how children respond to costs? In the Introduction, we proposed two measures to examine here: children's executive function skills (and in particular their inhibitory control skills) and children's verbal intelligence. Among all of the individual difference measures, we saw that the behavioral executive function measures (i.e., HTKS and Day/Night) were most related to children's performance on the main task (i.e., how frequently they chose the costly expert for his relevant questions). In addition, children who had lower HTKS and Day/Night scores were more likely to never assign the costly expert a question. Neither the working memory measure nor the parent and teacher reports of executive function skills related to performance on our primary task. Thus, inhibitory control skills that involve regulating behavior in general (e.g., saying the opposite word from a picture, performing a behavior different from what an experimenter has spoken out loud) relate most closely to successful waiting to assign questions to a costly but relevant expert.

In the current research, verbal intelligence did *not* relate to children's rate of assigning questions to the costly expert. We speculate that with our study design, children in this age range typically understood which expert was most appropriate for the different questions, and the main barrier to directing questions toward that expert was being patient enough to spend the cost to gather that information. But in other situations, having greater verbal intelligence might be more essential for inquiry. For challenging questions that children in a given age range may be less familiar with, having greater verbal intelligence may play a larger role in children's ability to make sense of the questions and think about appropriate ways to address them. Because engaging in successful inquiry involves multiple steps that vary in demands, it will be important for future research to examine the factors that contribute to success for different kinds of inquiry problems.

In the real world, information is not always immediately and easily accessible. Children who are *more* willing to pay a cost to gather information are more likely to end up gathering good-quality information than children who are not. Especially because so much of children's learning builds on previously learned information (e.g., mathematical concepts, science processes), it is vital that children gather good-quality information the first time around. This becomes increasingly important when considering how much harder it is for people to overwrite incorrect information they have already learned (see [Driver & Easley, 1978](#)); once children learn incorrect information, it may be more

difficult for them as they try to learn more or build on their existing knowledge. Similarly, those who value higher quality information and future academic success may be those who are more willing to endure costs to achieve it. Research has found that students who are better able to delay immediate gratification are often more academically successful because they are less likely to be distracted from studying by immediate activities, such as watching television and playing games, and are better able to see the future benefit of education (Bembenutty & Karabenick, 2004). In this way, willingness to gather the best information, even if there is a cost present, can help set children on the path toward successful future learning.

Although the current methodology is useful in understanding children's general behavior regarding seeking information when costs are present, there are limitations with this approach that should be addressed in future research. First, although presenting children with a doctor and a car mechanic allowed us to understand theoretically how children respond to different forms of cost, further research will benefit from exploring cost in relation to more common everyday sources that children encounter (e.g., mother, teacher). Second, this methodology did not take into account children's personal interest in the specific question topics. It is possible that when children are very invested in an answer (e.g., generating their own questions), they may be more willing to do whatever it takes to gather good-quality information. Third, the research design did not give children the opportunity to hear each question answered immediately after assigning it or to put that information to use (e.g., using the information learned to solve a problem). The current study's methodology was influenced by other research in cognitive development involving assigning questions to experts (e.g., Aguiar et al., 2012). In an experimental context, the method of requiring children to assign all questions before hearing the answers may help children to focus on how a question matches a particular person's expertise. It may also keep them from being biased by experiences that could be misleading (e.g., incorrectly assigning a question to an expert could cause children to doubt that expert in the future instead of recognizing that the question was incorrectly assigned). That said, another approach more akin to typical interactions would be for children to ask questions and immediately receive responses. Immediate feedback might increase children's investment in pushing through obstacles to gather information; alternatively, children might mistakenly interpret a poor answer to a question as a reason to give up inquiry instead of as a signal that they might want to try another possible source of information. These are issues for future research.

Overall, this research demonstrates that costs may act as a deterrent for children's information gathering. That said, at times children are willing to spend those costs in order to gather good-quality information. Here, we showed that inhibitory control skills play some role in children's willingness to wait for good information. Given the importance of obtaining good-quality information on learning, it is crucial for future research to examine the factors that influence children's information seeking. Especially with the emergence of technology and the ease with which younger children are now able to use it, coupled with the fact that it can be difficult to assess the legitimacy of the information found on the internet, it will be increasingly important to understand more about children's willingness to devote resources to gather the best information even if it is more difficult to do so. Insight into individual and contextual differences in how children approach learning from others has important implications for how we help to encourage the process of inquiry during childhood. Ultimately, understanding how children seek information from others under different circumstances will help to give us better insight into how to best facilitate children's learning.

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Appendix

Doctor-related, mechanic-related, and neutral questions

Domain	Question
Doctor-relevant knowledge	Why can't you get sick with chicken pox more than once? How can listening to your breathing help tell you if you're sick? How can you tell if a person is sick with tuberculosis? Where in your body is the tibia bone found?
Mechanic-relevant knowledge	How do you fix a flat tire? Why do cars need gas to work? What are cars made out of? Why do you need to rotate the tires on your car?
Political science-relevant knowledge (neutral domain)	Who decides how long people need to stay in jail? Why does the American flag have 13 stripes? Who determines who keeps the parks clean? Why do we celebrate Independence Day on the Fourth of July?

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