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## Children's Use of Majority Information Is Influenced by Pragmatic Inferences and Task Domain

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# Children's Use of Majority Information Is Influenced by Pragmatic Inferences and Task Domain

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Do children always conform to a majority's testimony, or do the pragmatics of that testimony matter? We investigated the influence of pragmatics on conforming to a majority across 2 domains: when learning about object labels and when learning about causal relationships. Four- and 5-year-olds ( $N = 250$ ) were given a choice between an object endorsed by a 3-person majority, or one endorsed by a single minority informant. Within each domain, there were 4 pragmatic conditions, each with modified testimony so that the majority either explicitly provided an opinion about or pragmatically implied their opinion about the alternative object chosen by the minority. In the unendorsed condition, informants explicitly unendorsed the unchosen object. In the implied condition, informants said nothing about the unchosen object. In the ignorance condition, informants explicitly expressed ignorance about the unchosen object, and in the hidden condition, the chosen object was the only one present at the time of the endorsement. We found that children were most likely to endorse the majority object in the unendorsed condition, in which the majority's opinion was explicitly stated, and least likely in the hidden condition, in which only one object at a time was present, with the other 2 conditions intermediate. Children's preference for majority testimony also depended on the task domain, with a stronger preference for the majority in the language task than causal task. Children might not simply have a majority bias; rather, they use majority information differently depending on the pragmatics and task demands.

*Keywords:* epistemic trust, consensus, pragmatics, social learning, testimony

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We humans are inherently social creatures, and throughout our daily interactions, we openly share our thoughts and opinions with one another. Learning from peers or adults can often be more efficient than individual learning, especially for young children who have a relatively small pool of previous experiences to draw on. When evaluating social testimony from others, children consider a variety of cues and information, and similar to adults, are influenced by the presence of a majority opinion or behavior (for a recent review, see Haun, van Leeuwen, & Edelson, 2013). Copying the majority in ambiguous situations may be particularly effective, as it can signal that a behavior is safe, adaptive, and

reliable (Boyd & Richerson, 1985; Boyd, Richerson, & Henrich, 2011; Wolf, Kurvers, Ward, Krause, & Krause, 2013). In fact, some previous researchers have theorized that copying a majority may be one possible human adaptation for enabling rapid cultural learning and cultural evolution (e.g., Henrich & Boyd, 1998). However, naively copying the majority group could also mean sometimes receiving misleading or inaccurate information, suggesting that to be maximally effective, learners should be discerning about how much weight they give to majority information (Boyd et al., 2011; Laland, 2004). When, then, are children more or less influenced by the presence of a majority?

Children might endorse the majority because it is a simple strategy that can serve as a proxy for reliability, especially when there are no other cues about the reliability of the informants available. Imagine you encounter a novel kitchen appliance and are not sure what it is called. However, several people tell you that the machine is a "Keurig." All else being equal, you are probably likely to now call it a "Keurig," too. Further, if there was another mystery appliance present and the group did not also label it as a "Keurig," you might infer that they believe that "Keurig" means only the first machine and not also the second one. Finally, if another person referred to just the second machine as a "Keurig," you would likely think they were mistaken, because it is more likely that a single person rather than the majority was incorrect.

Individuals in this example might first use majority as a proxy for reliability, but when pragmatic communicative cues are avail-

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able also incorporate those into their decision making. In this case, if individuals assume that speakers are being informative about what they are labeling, then they might reason that

The majority must only believe that Machine X is the Keurig, as they only labeled Machine X and did not comment on Machine Y. If the majority wanted me to know that Machine Y is also a Keurig, then they would have told me, because they had the opportunity to speak about Machine Y (e.g., commenting on both machines).

Children may learn in similar ways.

In addition, when learning about domains that are heavily socially constructed (e.g., object labels), testimony from others should be highly valuable, because the relevant knowledge is transmitted primarily or solely through others, and children cannot easily learn this type of information on their own. By contrast, in a less socially constructed domain (e.g., cause-and-effect learning), children will also have the opportunity to gather nonsocial evidence (e.g., observing whether the actions performed are causally effective). In this study, we examine whether the pragmatic communicative intent of the majority as well as the domain being learned about would impact how children learn from majority information.

## Background

As previously mentioned, a bias to copy the majority simply because it is the majority can often lead to learning adaptive behaviors in a quick and efficient way, because the presence of a majority might be an indicator of reliability (Corriveau, Fusaro, & Harris, 2009). In fact, both children and adults sometimes copy a majority. For instance, Corriveau et al. (2009) found that 3- and 4-year-old children were more likely to prefer novel labels that were endorsed by the majority. Slightly older children (4- and 5-year-olds) also trusted the majority group in word learning, even after the majority was subsequently shown to have labeled the objects inaccurately (Bernard, Proust, & Clément, 2015). Similarly, in other domains, children also preferred to copy the action demonstrated by the majority (Haun, Rekers, & Tomasello, 2012).

Adults often copy a majority in situations of uncertainty, especially as the size of the majority increases (e.g., Coultas, 2004; Morgan, Rendell, Ehn, Hoppitt, & Laland, 2012), and recent work has theorized that adults might routinely “outsource” much of their reasoning by relying on consensus opinions (Sloman & Rabb, 2016). Classic studies in social psychology have similarly shown that adults sometimes override their own existing opinions to follow the majority (Asch, 1956; Cialdini & Goldstein, 2004), which can result in internalization of the consensus opinion (Kelman, 1958; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; see Corriveau & Harris, 2010, for a similar result in children).

Nonetheless, recent work suggests that adults can also go beyond simply copying the majority in order to examine the quality of the majority’s testimony, for instance, relying on majority information less when they are confident in their own knowledge (Morgan et al., 2012) or preferring the option endorsed by a minority with direct information over a majority with only hearsay (e.g., Hu, Whalen, Buchsbaum, Griffiths, & Xu, 2015; Whalen, Griffiths, & Buchsbaum, 2018). Young children, though, sometimes continue to rely on the majority opinion, even when that

opinion is based on a lower quality of information (Hu et al., 2015; Morgan, Laland, & Harris, 2015; Otsubo, Whalen, & Buchsbaum, 2017).

It is therefore possible that children might copy the majority more broadly than adults and always or often use the presence of a majority as a simple heuristic for reliable knowledge (Corriveau et al., 2009), perhaps enabling rapid cultural learning. On the other hand, young children are able to engage in more selective social learning in other situations. For instance, when choosing between individual informants, children can selectively learn from informants who display indicators of reliable knowledge, such as past accuracy (e.g., Pasquini, Corriveau, Koenig, & Harris, 2007; Vanderbilt, Heyman, & Liu, 2014) or knowledgeability (e.g., Koenig, 2012; Koenig, Clément, & Harris, 2004), among other cues that indicate reliability of the testimony (for a review, see Koenig & Sabbagh, 2013; Mills, 2013; Sobel & Kushnir, 2013). This suggests that there might be cases in which they can also evaluate majority information more critically.

One particularly important consideration when learning from testimony is the pragmatic intent of the speaker. Grice (1975) proposed that participants in conversation obey the maxims of cooperative communication—be truthful, informative, relevant, and clear. The *maxim of quantity* (be informative) and the *maxim of relevance* (be relevant) are both particularly important for motivating the current study, in which we examine the role of pragmatic inferences on children’s learning from testimony. To be informative means to give as much information as needed, and no more. To be relevant means to only say things that are pertinent to the given context. Children might assume informants are being informative and relevant with their testimony, influencing what they learn. Therefore, as in our Keurig example, pragmatic inferential skills might help children determine circumstances under which they would (or would not) benefit from learning from the majority group.

There is mixed evidence about preschool-age children’s ability to use pragmatic knowledge to make inferences about a speaker’s knowledge and intent. On the one hand, children as young as 2 years old were able to use pragmatic cues to learn that adults were likely to talk about objects novel to them and label it with a new word (Akhtar, Carpenter, & Tomasello, 1996). On the other hand, children younger than 7 years have difficulty inferring scalar implicatures, for instance, inferring that *some* means *not all* (e.g., Noveck, 2001). However, recent studies by Frank and Goodman (2012, 2014) provide evidence that 3- and 4-year-old children can use the Gricean maxim of quantity to make pragmatic inferences about the speakers’ communicative intentions during word learning.

In a typical reference game paradigm, there are multiple potential referents (e.g., two dinosaurs), who all have some shared properties (e.g., a tie, glasses), except one potential referent also has an additional unshared feature (e.g., a hat). When the learner hears the speaker say for example, “the dinosaur with a dax,” they need to infer whether “dax” means tie, glasses, or hat to determine to which dinosaur the speaker is referring. Although, in theory, “dax” could refer to any of the visible features, if children assume speakers are being informative and relevant, then “dax” must mean hat, because it is the only item that uniquely identifies just one dinosaur. Indeed, Frank and Goodman (2014) found that when

children encounter such a situation, they infer that “dax” means the unique feature.

Knowing that children are learning through pragmatic inferences as well as explicit testimony can potentially help us understand what children are learning from a majority group. In previous studies that found that children conform to a majority (e.g., Corriveau et al., 2009), the majority’s opinion of the minority has usually been left ambiguous, and as in our Keurig example. This may have inadvertently led children to infer that the majority did not endorse the minority’s choice (“The majority must only believe that Object X is a modi because they had the opportunity to also label Object Y”). In this study, we examine whether pragmatic cues may provide additional information for reliability when other information (e.g., accuracy) is unavailable.

This pragmatic reasoning is also consistent with a strong pragmatic principle that is typically argued to constrain word learning—the mutual exclusivity assumption (Markman, 1990). If an object already has a commonly used label, then a novel label is unlikely to refer to that object (e.g., when asked for the “chromium” colored item, children do not choose the yellow item, because if the speaker had intended the yellow item, they would have used the shared label “yellow”; Carey & Bartlett, 1978). Returning to our Keurig example, this could strongly imply that the options are mutually exclusive and only one object is a Keurig. Therefore, if the majority and minority disagree, it is unlikely that they are both correct. Accordingly, when presented with conflicting testimony between a three-person majority and a single minority informant, this might have led children to strongly favor the majority label.

However, imagine if, in our Keurig example, only one machine was present on the counter when the majority group came in, while the single individual only saw the other machine (and did not know about the existence of the first machine). Even though the explicit testimony has not changed—both groups still only label a single machine as a “Keurig”—the pragmatics evoked by the situation changes. Because people typically only comment on objects that are present in the communicative context, unlike in the first scenario when both machines were always present, the majority group is not necessarily disagreeing with the minority. Instead, it is possible that both machines may be called a “Keurig.”

Further, domain demands might also affect the weight children place on the majority’s testimony. A tendency to copy the majority might be especially effective when learning words because word-meaning relationships are socially constructed—the word “yellow” refers to the color yellow exactly because that is how the majority of English speakers use it. In contrast, when learning about a domain that is less socially constructed such as causal relationships, knowledge can be gained through personal observation as well as through social transmission—we can observe that flipping a light switch produces the effect of turning on the light.

As well, although the word “yellow” and the word “blue” are unlikely to both refer to the same color (and the frequency of usage by the majority of language speakers is more likely to be correct), there may be more than one way to, for example, turn on a light. Therefore, learning cause-and-effect relationships leave open the possibility that multiple causes can lead to the same effect, and that both the majority and the minority can be correct, even when they disagree. Indeed, much of the literature suggesting that children tend to favor learning from a majority, or that they exhibit a

majority bias, has been done in the domain of object labels (e.g., Bernard et al., 2015; Corriveau et al., 2009).

Domain demands may help explain why previous studies on learning from majorities in nonlinguistic contexts have yielded mixed findings. Haun et al. (2012) showed that children as young as 2 years old were more likely to copy the majority’s method of getting a reward from a puzzle box. They even switched their preference to that of the majority’s behavior when given another opportunity to play with the puzzle box (Haun, Rekers, & Tomasello, 2014). On the other hand, when the majority group demonstrated a novel action that was unsuccessful (Wilks, Collier-Baker, & Nielsen, 2015), inefficient (Evans, Laland, Carpenter, & Kendal, 2018), or implausible given the nature of the object (e.g., an object with holes is used for drinking), children reduced their tendency to go with the majority (DiYanni, Corriveau, Kurkul, Nasrini, & Nini, 2015; Schillaci & Kelemen, 2014). In this case, consensus was not a powerful enough justification for copying an action that was inefficient or implausible. Relatedly, children were also equally likely to copy the instrumental actions of either a majority or a previously competent individual, and most children made consistent choices, suggesting that they were not indiscriminately copying the majority (Burdett et al., 2016). Although an intriguing possibility, these studies also differed from the studies on word learning in many other respects (e.g., age group studied; size of the majority; presence or absence of a dissenting minority), making a direct comparison difficult. To our knowledge, no previous studies have directly compared how children use majority information to guide learning across domains, in particular, learning object labels compared with learning causal relationships (see Schillaci & Kelemen, 2014, for a related theoretical discussion).

Nonetheless, pragmatic inferences may also apply to learning cause-and-effect relationships. For instance, when a teacher demonstrated a single action that produced a successful outcome (e.g., toy squeak), children spent more time squeaking the toy, as this implied that other actions afforded by the object might not activate the toy (e.g., toy spin); otherwise, the teacher would have demonstrated them as well (Bonawitz et al., 2011). Relatedly, when the majority makes a point of demonstrating Action X and does not also demonstrate Action Y (e.g., Haun et al., 2012), this might provide evidence against the minority’s action, thereby affecting children’s reasoning about majority information. Although causal actions on objects might not inherently be constrained by a pragmatic mutual exclusivity assumption, having a majority group activate the toy one way and the minority informant activate the toy another way might imply to children that one casual action—specifically, the majority’s action—may be more effective than the other causes, even if they did not observe this difference themselves.

Taken together, the conventional nature of language and the fact that an effect can have multiple causes (i.e., domain demands), in addition to pragmatic cues, should affect the weight children place on the majority’s versus minority’s testimony. In the present study, we aim to understand how children use majority information across pragmatic conditions and how this might change across task domains. We compared 4- and 5-year-old children’s preference for the majority when the informants do and do not provide an explicit opinion about the minority’s choice in their testimony. As well, we systematically compare children’s tendency to endorse majority

information when learning about object labels and when learning about causal relationships.

### Pragmatic Knowledge Versus Consensus

Across all conditions, we presented preschoolers with testimony from four informants—a three-person majority and a conflicting minority informant—as they identified the referent of a novel label in the object labeling task or as they demonstrated a novel action that resulted in the object playing a song in the causal learning task. The object (action) chosen by the informant was referred to as their *endorsed object* (action). There were four pragmatic conditions—the unendorsed condition, the implied condition, the ignorance condition, and the hidden condition—that differed in terms of informativeness of the testimony and relevance of the object(s) present in the situation (see Table 1).

In the most explicit case, the unendorsed condition, the majority chose one object as being called a, for example, “modi” in the language task or one action as activating the toy in the causal task, and also stated that the other object was not a modi or that the other action was ineffective, respectively. The minority informant provided the opposite testimony, endorsing the object or action that the majority had not chosen and unendorsing the object or action that they had chosen. Here, children are learning from declarative testimony that makes the extent of the novel label or action explicit, and no pragmatic inference is needed in order to understand the communicative intent of the speakers. We hypothesized that this testimony should provide the strongest evidence against the minority label or action. Because the testimony in this condition explicitly states that only one label or action is correct, the testimony provided by the majority group should outweigh the evidence provided by just one minority informant.

In the implied condition, the informants endorsed one object or action and said nothing about the other option. This condition was intended to replicate the testimony structure in previous work, in which the informants’ knowledge or belief about the unchosen object was left ambiguous. We predicted that children would favor the majority endorsement because they would make a pragmatic inference that the speakers are using language informatively. The majority must believe that the novel label or action does not apply to the unchosen object; otherwise, they would have referred to the unchosen object using the label or action as well. Therefore, similar to the unendorsed condition, children in the implied con-

dition might infer that only one label or action is correct and, thereby, endorse the majority information. However, we predicted that they should endorse the majority less often than in the unendorsed condition because there is additional ambiguity compared with when the majority explicitly states their opinion.

In the ignorance condition, the informants endorsed one object but expressed ignorance about the unchosen object. That is, the informant clearly identified the item they knew was a “modi” (language task) or identified the cause they knew resulted in music (causal task) while also stating that they did not know whether the other object was also a modi or whether the other action would also lead to music, respectively. Because the majority is expressing ignorance (lack of knowledge) about the extension of the novel label or the causal effectiveness of the minority action, their testimony should carry less weight in determining whether the unchosen object can also be referred to using the novel label or whether the alternative action is equally effective. Further, the informants’ ignorance suggests that more than one label or action could be correct. Thus, if children interpret ignorance in the testimony, then there should be less evidence against the minority’s choice and, by association, against the minority. We predicted that children in the ignorance condition should be less likely to endorse majority testimony when compared with the unendorsed and implied conditions.

Finally, the verbal testimony in the hidden condition was exactly the same as in the implied condition, but only one object—the endorsed toy or action to activate the toy—was visible. The hidden condition relies on the pragmatic understanding that the speaker is being informative and relevant in their testimony and is therefore only speaking about objects that are present in the discourse context. The result is that, if children make this pragmatic inference—speakers will not comment on objects that they and their communicative partners do not see—then in the hidden testimony, the majority provides no or the least amount of evidence against the minority’s choice, and children should be most likely to endorse both options equally. On the other hand, if children are not sensitive to the pragmatics of the testimony, then the results of the hidden condition should be the same as the implied condition. That is, children should endorse majority information over the minority’s choice given that the explicit verbal testimony is identical in these two conditions.

Table 1

Summary of Verbal Testimony of the Informants in a Language Task and Causal Task

Pragmatic conditions	Language task	Causal task
Unendorsed condition	“That’s a <i>modi</i> [pointing to target toy]; that’s not a <i>modi</i> [pointing to other toy].”	“It plays music when you <i>pull the pink ring</i> , but not when you <i>pull the yellow star</i> .” [performs action to activate music]
Implied condition	“That’s a <i>modi</i> .” [pointing to target toy]	“It plays music when you <i>pull the pink ring</i> .” [performs action to activate music]
Ignorance condition	“That’s a <i>modi</i> [pointing to target toy]; I don’t know if that’s a <i>modi</i> [pointing to other toy].”	“It plays music when you <i>pull the pink ring</i> , but I don’t know about when you <i>pull the yellow star</i> .” [performs action to activate music]
Hidden condition (with only one object/function present)	“That’s a <i>modi</i> .” [pointing to target toy]	“It plays music when you <i>pull the pink ring</i> .” [performs action to activate music]

Note. The statement was said once by each majority informant and repeated three times by the minority informant while endorsing the opposite toy.

We also expect domain differences, and thus the pragmatic conditions are compared across two task domains. We predicted that children should have an overall stronger preference for majority information in the word learning task because language is conventionalized and relies on the mutual exclusivity assumption that reduces the extension of object labels onto multiple distinct object categories. We also expected the effect of pragmatics to be most pronounced in this task. If children consider pragmatics in their learning, then as majority testimony becomes less informative about the alternative object, children should be less likely to adopt the majority's endorsement over the option endorsed by the minority informant: unendorsed condition (most majority endorsement); then, implied condition; then, ignorance condition; and finally, the hidden condition should exhibit the least majority bias. However, if children use a simple strategy of relying on the majority, then they should always endorse majority regardless of the pragmatics.

In contrast, children in the causal task can directly observe the effect of causes, so they are learning not only from testimony but also from personal observations. In addition, there can be more than one way to activate a toy. Thus, we predicted that children should have an overall reduced tendency to endorse the majority group in the causal task, especially when the testimony suggests that multiple causes are plausible. If children are just learning from personal observations during the causal task, they would have seen that both actions are effective and so might not have a preference for the majority over the minority in any condition. Alternatively, if children in the causal task continue to be sensitive to the strength of majority testimony, then majority endorsement should vary with the pragmatic conditions, following the same trend as in the language task. Finally, if children exhibit a global conformity bias across task domains, then they should indiscriminately endorse the majority's opinion, regardless of the pragmatic conditions, equally across both domains.

## Method

In this experiment, there are four pragmatic conditions—the unendorsed, implied, ignorance, and hidden conditions—and two task domains—the language (i.e., object labeling) and causal (i.e., causal learning) tasks. The data and analyses can be found on Open Science Framework at [osf.io/qnv8d](https://osf.io/qnv8d), and the stimuli are presented in the online supplemental materials.

## Participants

Overall, there were 250 participants Ages 4 ( $n = 123$ ) and 5 ( $n = 127$ ) years old, with 112 females and 138 males ( $M$  age = 60 months,  $SD = 7$  months). All participants were typically developing children who spoke at least 75% English in their day-to-day lives, according to parental reports. Participants were recruited at the local university ( $n = 1$ ), neighborhood parks ( $n = 3$ ), and museums ( $n = 246$ ). A range of ethnicities resembling the diversity of the population was represented (see the online supplemental materials). Participants were randomly assigned to either the language task ( $n = 123$ ) or causal task ( $n = 127$ ). Then, within each task domain, they were randomly assigned among the four between-subjects pragmatic conditions: the unendorsed (language,  $n = 32$ ; causal,  $n = 32$ ), implied (language,  $n = 30$ ; causal,  $n =$

32), ignorance (language,  $n = 31$ ; causal,  $n = 31$ ), and hidden (language,  $n = 30$ ; causal,  $n = 32$ ) conditions.

An additional 62 children were excluded from the study<sup>1</sup> (see the online supplemental materials for details of participant exclusions). The age, demographic, and language backgrounds of the excluded children are similar to the sample included in the study. The study was approved by the Institutional Research Ethics Board for Human Subjects at the University of Toronto (Protocol # 30,903: The Development of Casual and Social Learning in Children).

## Materials

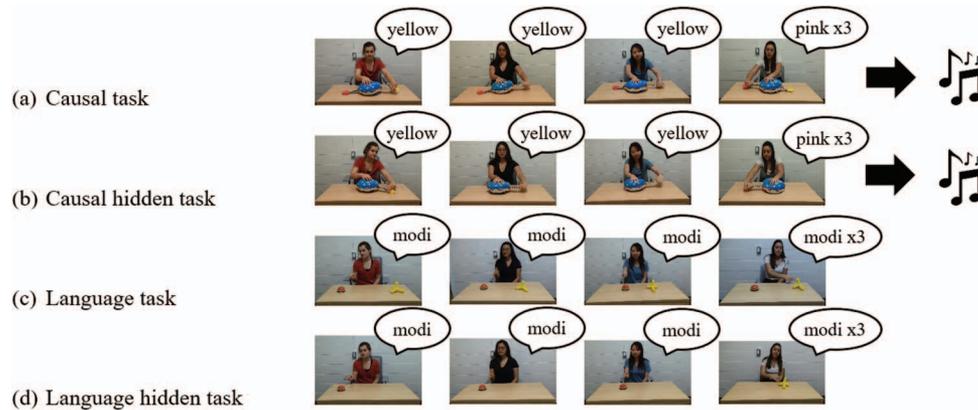
In the object labeling task, the stimuli included four unique objects to reduce object label extension (see Figure S1 in the online supplemental materials), with each trial featuring a pair of novel objects. In the causal task, stimuli were two plush toys, each of which contained a wireless doorbell (see Figure S3 in the online supplemental materials). The experimenter activated the toy when the child acted on the toy to create the illusion that children's actions were causally efficacious. A 13-in. laptop screen was used for presenting the prerecorded video stimuli of informants' testimonies.

## Procedure

Children were tested individually. Each participant participated in two test trials of their condition (e.g., a "modi" trial and a "dax" trial for the language task). A pair of novel objects (language task) or functions (causal task) were presented for each trial. The pair presented first was counterbalanced across participants. Each item was endorsed by the majority equally often, and the majority endorsed the right- and left-hand-side objects equally. The actor playing the minority informant stayed the same across trials within a participant but was counterbalanced across participants.

The child sat at a table across from the experimenter. In the language task, the experimenter introduced the child to two novel objects and told the child that they were unknowledgeable about the labels of the objects, for example, "There's something called a modi but I don't know which ones." In the causal task, they were introduced to the novel object and the experimenter told the child, "This toy makes music, but I don't know how to make it play music." The experimenter suggested that the child watch a film to learn about the objects' labels or functions (e.g., "Let's ask some people in the video to see what say"). They then watched a prerecorded film of four female informants (all wearing different colored shirts) providing their testimony. In brief, the film con-

<sup>1</sup> As part of our agreement with the local museum, all children were allowed to participate in the studies offered on a given day. This allowed us to recruit a greater range of children than needed but also resulted in higher dropout and error rate because of the setting (e.g., noisier environment). Therefore, an additional 17 children who did not meet the study inclusion criteria as they were outside the age range, not fluent in English, or did not have parental consent also participated in the study but were excluded a priori and will not be discussed further. Twenty additional participants were run as unnecessary replacements for participants who were not excluded. An alternative analysis including these participants is presented in the online supplemental materials and does not change our findings.



*Figure 1.* Examples of video clips. (a) Stimuli placements for the unendorsed, ignorance, and implied condition (two functions present) in the causal task. (b) Stimuli placement for the hidden condition (one function present) in the causal task. (c) Stimuli placements for the unendorsed, ignorance, and implied condition (two toys present) in the language task. (d) Stimulus placement for the hidden condition (one toy present) in the language task. The authors received signed consent for the individuals' likenesses to be published in this article. See the online article for the color version of this figure.

sisted of four video clips of three majority informants and one minority informant evaluating the object (see Figure 1).

Each clip began with a single informant sitting by herself at a table with the novel object(s). In the first three clips, the three-person majority each endorsed one object with the novel label (language task) or demonstrated one action that caused the toy to play music (causal task). In the final clip, the single minority informant endorsed the other object with the same novel label or demonstrated the other action, repeated three times so that the frequency with which each participant heard the label used to refer to each object or saw each action successfully demonstrated was equivalent.<sup>2</sup> Figure 1 displays a schema for the videos shown.

For examples of the testimony used in each condition, refer to Table 1. Exact testimony is given in the online supplemental materials. In the unendorsed condition, with two objects or two actions present, each majority informant endorsed one object or action while explicitly unendorsing the other choice. In the implied condition, although two objects or actions were present, the majority informants endorsed only one option and did not comment on the other choice. In the ignorance condition, with two objects or actions present, each majority informant endorsed one object or action while expressing ignorance about the other one. In the hidden condition, the informant sat at the table with only one object or action present and only evaluated that object in their testimony. After the video clips, the experimenter presented the child with the objects and asked them to identify a referent of the novel label (e.g., "Can you show me a modi?") or to make the toy play music (e.g., "Can you show me how this toy plays music?").

### Coding

In the object labeling task, the item that the child first selected by gesturing, pointing, or saying, for example, "That's a modi," was considered their choice. Similarly, in the causal task, the action that child identified as causing music or acted on was considered their choice. A minority of children in both tasks immediately and spontaneously changed their minds before the

experimenter's next question, and in these cases, their final choice was recorded as their answer.

Participants were assigned a score in each trial to indicate whether or not they chose the majority informants' object: a score of "0" if they did not endorse the majority object and a score of "1" when they did. If they endorsed the majority object in both trials, then they would receive a total score of 2. A small number of children (16 children in the language task and 17 children in the causal task) explicitly answered "both" either verbally (object labeling) or by acting on both actions simultaneously (causal task). These children were coded as not going with the majority on that trial. If children chose both objects, the experimenter also asked a follow-up forced-choice question to prompt a selection of one object. We inadvertently did not force-choice a small number of participants.

All responses for participants were coded online. All responses with video (79%) were again coded offline by the first author and a researcher blind to the experiment hypotheses. Agreement was high for the total score indicating the number of trials in which participants endorsed majority testimony (93%; 182/196). Cohen's unweighted kappa ( $\kappa$ ) analysis revealed that this agreement was substantial ( $\kappa = 0.89$ ).

### Results

Participants were assigned a score (0, 1, or 2) based on the number of trials in which they endorsed the majority informants' testimony (see Table 2). Children's mean responses for all conditions are shown in Figure 2. For all conditions, chance level was a

<sup>2</sup> Pilot testing showed that there was no primacy or recency effect when the single dissenter was presented first versus last, and so we chose to keep a fixed order of testimony (with the dissenter last) to simplify our experiment design, similar to previous work (e.g., Burdett et al., 2016; Haun et al., 2012; Schillaci & Kelemen, 2014), as we were primarily interested in comparisons across task domains and pragmatic conditions. This order was held constant across all of the conditions, so that the relative tendency to go with the majority would not be influenced by informant order.

Table 2  
*Number of Participants Choosing the Object Endorsed by the Majority Group Across Task Domain and by Condition*

Pragmatic conditions	Language task				Causal task				
	0	1	2	<i>M</i> ( <i>SD</i> )	0	1	2	<i>M</i> ( <i>SD</i> )	
Unendorsed	0	4	28	1.88 (.34)	5	9	18	1.41 (.76)	
Implied	6	9	15	1.30 (.79)	5	16	11	1.19 (.69)	
Ignorance	5	9	17	1.39 (.76)	8	13	10	1.06 (.77)	
Hidden	9	15	6	.9 (.71)	9	12	11	1.06 (.80)	

mean score of 1. In a preliminary analysis, we found no differences across age groups or the two types of trials within task domains (see the online supplemental materials). As a result, data were collapsed across age groups and trial type in all the remaining analyses.

First, we fit a 2 (task domain)  $\times$  4 (pragmatic condition) ANOVA<sup>3</sup> with planned orthogonal polynomial contrasts to determine to what extent majority endorsement changed across pragmatic conditions and was influenced by task domain. We chose to use orthogonal polynomial contrasts, which test for linear trends across ordered conditions, as well as potential deviations from linearity, because we predicted a decreasing trend in majority endorsements across our pragmatic conditions. As well, we predicted a potential difference in the overall level of endorsements, and perhaps in the slope of the decrease, across task domains (see the online supplemental materials for contrast weights and some additional discussion). All significant results are reported with a two-tailed *p* value.

There was a main effect of pragmatic condition,  $F(3, 242) = 9.03$ ,  $\eta_p^2 = 0.10$ ,  $p < .001$ , and task domain,  $F(1, 242) = 4.29$ ,  $\eta_p^2 = 0.017$ ,  $p = .039$ . The interaction between pragmatic condition and task domain approached significance,  $F(3, 242) = 2.29$ ,  $\eta_p^2 = 0.028$ ,  $p = .079$ . Because there was a marginal interaction between pragmatic condition and task domain, we examined the polynomial trends within each domain separately. Polynomial contrasts for main effects indicated significant linear trends in both the language task ( $\beta = -2.84$ ,  $SE = .58$ ,  $p < .001$ ) and the causal task ( $\beta = -1.15$ ,  $SE = 0.57$ ,  $p = .043$ ). The significant linear trend suggests that the mean score for majority endorsement decreased across pragmatic conditions in both domains, with the most endorsement for the majority in the unendorsed condition and least in the hidden condition (see Figure 2). There was no quadratic trend in either task (language:  $\beta = 0.088$ ,  $SE = 0.26$ ,  $p = .73$ ; causal:  $\beta = 0.22$ ,  $SE = 0.25$ ,  $p = .39$ ). There was a cubic trend in the language task ( $\beta = -1.24$ ,  $SE = 0.58$ ,  $p = .03$ ) but not in the causal task ( $\beta = 0.025$ ,  $SE = 0.57$ ,  $p = .96$ ). This suggests that, in the language task, there was also some deviation from a linear trend across pragmatic conditions, a point we will return to in the ‘Language Task’ section.

We used planned contrasts to compare the difference in polynomial trends across tasks. There was a significant difference in the linear trend across pragmatic conditions between the language and causal tasks ( $\beta = -1.68$ ,  $SE = 0.81$ ,  $p = .038$ ) but not in the quadratic ( $\beta = -0.13$ ,  $SE = 0.36$ ,  $p = .72$ ) or cubic ( $\beta = -1.26$ ,  $SE = 0.81$ ,  $p = .12$ ) relationship. A visual inspection of Figure 2 confirms that although the greatest endorsement of majority information was in the unendorsed condition and the least in the hidden condition across both task domains, the decrease is steeper in the

language task, with a smaller and more gradual decline in the causal task; however, there was no significant difference in the ordering of the conditions. We next examined children’s performance within each task domain.

### Language Task

As can be observed in Figure 2, children in the language task were overall more likely to endorse the majority group than in the causal task. Children chose the majority’s label for the object significantly more often than chance in the unendorsed,  $t(31) = 14.73$ ,  $d = 2.59$ ,  $p < .001$ , implied,  $t(29) = 2.07$ ,  $d = 0.38$ ,  $p = .048$ , and ignorance,  $t(30) = 2.83$ ,  $d = 0.51$ ,  $p = .0081$ , conditions. However, there was no preference for the majority group in the hidden condition,  $t(29) = -0.77$ ,  $d = 0.14$ ,  $p = .45$ .

We used planned comparisons to follow up the effect of pragmatic condition within each task. Given the small but significant cubic trend in the language task, we were particularly interested in deviations from a strict decreasing trend across pragmatic conditions. A qualitative examination of the condition means suggests there was no decrease, and possibly an increase, in majority endorsements between the language implied and ignorance conditions (see Figure 2). However, there was no significant difference in children’s performance in the implied condition compared with the ignorance condition ( $M_{\text{difference}} = -0.087$ ,  $SE = 0.18$ ,  $p = .64$ ; Fisher’s least significant difference [LSD]). Comparisons between the remaining conditions revealed that the unendorsed condition was significantly different from all other conditions ( $M_{\text{difference}} \geq 0.49$ ,  $SE \leq 0.18$ ,  $p \leq .0074$ ). The hidden condition was also different from the other conditions ( $M_{\text{difference}} \geq 0.40$ ,  $SE \leq 0.18$ ,  $p \leq .023$ ). Overall, the results indicate that in the language task, there was a stronger preference for majority in the unendorsed condition and no preference in the hidden condition, whereas the preference for majority in the implied and ignorance conditions was moderate and did not differ from each other. This is consistent with the overall finding of a decreasing trend across pragmatic conditions.

<sup>3</sup> Analysis was done in R using packages *car*, Version 3.0 (Fox & Weisberg, 2011), and *emmeans*, Version 1.3.0 (Lenth, 2019). Although scores of 0–2 violate some ANOVA assumptions, simulations on a similar data set suggest that our tests are robust to these violations. An alternative analysis using a mixed effects logistic regression model is presented in the online supplemental materials and does not substantially change our findings, suggesting that they are robust to the specific choice of statistical analysis. We present the ANOVA in the main text, as it is likely to be most familiar to readers.

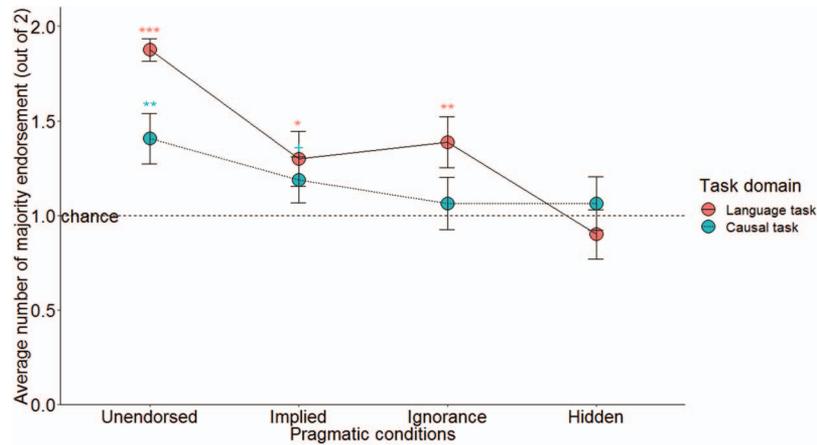


Figure 2. Average number of responses ( $\pm 1$  SE) endorsing the majority object. There was a significant effect of pragmatic condition and task domain. Children chose the majority's object most often in the unendorsed condition, and least often in the hidden condition, with overall greater endorsement in language than causal task. +  $p < .10$ . \*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ . See the online article for the color version of this figure.

### Causal Task

Similar to the language task, children in the unendorsed condition of the causal task chose the majority's action at significantly above-chance levels,  $t(31) = 3.04$ ,  $d = 0.54$ ,  $p = .0048$ . There was also a trend towards choosing the majority's action in the implied condition,  $t(31) = 1.53$ ,  $d = 0.28$ ,  $p = .068$ , providing suggestive evidence that children had a (weaker) preference for the majority in this condition. However, children were equally likely to choose the majority's or minority's action in the ignorance,  $t(30) = 0.47$ ,  $d = 0.08$ ,  $p = .32$ , and hidden,  $t(31) = 0.44$ ,  $d = 0.08$ ,  $p = .33$ , conditions. Paired comparisons between the individual conditions in the causal task showed a trend that was similar to the one found in the language task. The unendorsed condition was marginally different from the ignorance condition ( $M_{\text{difference}} = 0.34$ ,  $SE = 0.18$ ,  $p = .059$ ; Fisher's LSD) and hidden condition ( $M_{\text{difference}} = 0.34$ ,  $SE = 0.18$ ,  $p = .056$ ). However, comparisons between the remaining conditions did not approach significance ( $M_{\text{difference}} \leq 0.13$ ,  $SE \geq 0.18$ ,  $p \geq .49$ ).

### Secondary Analysis of "Both" Responses

As previously mentioned, a small number of children endorsed both the majority and minority group (see Table 3). Because our task structure manipulated the evidence for how likely both objects or actions were to be correct, we conducted a follow-up analysis of

the distribution of "both" answers. The distribution of "both" answers across pragmatic conditions was significantly different,  $\chi^2(3, N = 33) = 16.33$ ,  $V = 0.41$ ,  $p = .001$ , with children most likely to endorse both the majority and minority objects in the hidden conditions and least likely in the unendorsed conditions. In fact, no child in the language task endorsed both objects with one label in the unendorsed condition. We were also able to ask a follow-up with a forced-choice question for 24 trials (out of 40 trials in which participants endorsed both the majority and minority testimony). We found that children who had previously answered "both" endorsed the majority in 19 of those trials (see the online supplemental materials for analysis of children who mentioned "both" at any point in the experiment).

### Discussion

This study provides the first empirical evidence showing that pragmatic implications and domain demands affect the weight that preschool-age children place on majority testimony. Laland (2004) argued that social learning—and, in particular, a tendency to copy the majority—can be adaptive but only when it is selective (see also Boyd & Richerson, 1995). The results of this study support that children are selective social learners even when learning from majorities.

Children were most likely to copy the majority when the evidence strongly favored the majority's choice. That is, when the domain was conventional and when majority testimony provided the strongest evidence against the minority's choice and they were flexible and selective about copying the majority in other circumstances. Children's preference for majority information increased with the strength of the majority's explicit or pragmatically implied disagreement with the minority, with the strongest preference for majority in the unendorsed condition, whereas they were at chance when the majority provided the least amount of evidence against the minority's choice in the hidden condition. Moreover, the influence of the majority differed depending on task domain. Children in the language task had an overall stronger preference

Table 3

Number of Participants Who Endorsed Both Objects or Actions by Condition and Task

Pragmatic conditions	Language task	Causal task	Total
Unendorsed	0	3	3
Implied	2	3	5
Ignorance	4	3	7
Hidden	10	8	18
Total	16	17	33

for majority across the pragmatic conditions than children in the causal task.

Previous evidence on young children's ability to use Gricean maxims has been mixed (e.g., Frank & Goodman, 2014; Noveck, 2001). Our study supports that preschool children are capable of going beyond the literal meaning of the testimony to make sophisticated inferences about implicit, intended meaning in individual speakers' utterances, and demonstrates that this ability extends to evaluating agreement among multiple informants. When learning from explicit, declarative testimony, as was the case in the unendorsed condition, following the majority is a sensible strategy because the explicit endorsement of only one object or action by three people might outweigh the evidence provided by just one disagreeing minority informant. Children were also more likely to endorse the majority in the implied condition (replicating the findings in previous work; e.g., Corriveau et al., 2009). And yet in this condition, the majority had less of an influence compared to the unendorsed condition, suggesting that children are aware of the additional ambiguity in this condition. By contrast, children did not exhibit a majority bias in the hidden condition. This suggests that children understood the pragmatics involved in this testimony. When there is only one object available in the current context, informants should only label that object if they are following the pragmatic principles. In this case, children did not interpret the lack of endorsement for the other object to be evidence against the label also applying to that object.

Recall that the testimony in the implied and hidden conditions was identical but that either both objects or only one object was present in the context, respectively. Therefore, the crucial difference between these conditions is in the pragmatic inferences made from the informants' testimony given the ambiguity of the learning situation. When the majority's opinion of the alternative object is ambiguous, as in the implied and hidden conditions, children rely on pragmatic cues to infer the speaker's intent. According to the pragmatic account, a crucial step in the inferential process is the assumption that the speaker, in this case, the informant, is being cooperative with their utterance, and has the goal of being informative and relevant. If the speaker had wanted to label both objects, then they had the ability to do so (as in the unendorsed and ignorance conditions). The fact that the informants only ever labeled one object in the implied condition led children to infer that the novel label is most likely only applicable to one object in the given situation.

However, in the hidden condition, only one object was present, invoking a different pragmatic inference than in the implied condition—the inference that speakers are only discussing objects relevant to the current situation. Consequently, even though the testimony in these two conditions was identical, children's inferences differed and, in turn, led to differential effects of majority influence. Children in the implied conditions were more likely to side with the majority, yet children in the hidden conditions showed no preference. This suggests that children's inferences from consensus are influenced by their sensitivity to pragmatic cues embedded in the testimony.

Another important factor to consider when learning from testimony is domain demands. In fact, we saw that there was a difference in the overall level of majority endorsement when comparing the results across task domain. Children in the causal task were less likely to endorse majority information than children

in the language task. This might be most evident in the unendorsed condition. Although children in both tasks displayed a strong preference for the majority group, children in the language task were almost at ceiling, whereas children in the causal task endorsed majority information at a reduced rate. When children received feedback to show that both the majority's and minority's action were equally efficacious, as was the case in the causal task, they did not rely solely on majority testimony.

In the causal task, the direct effects of causes can be observed. Hearing the toy play music quantified the effect of potential causes and children saw that both the majority's and minority's action brought about the effect equally often. As well, causal actions on objects are not typically mutually exclusive by nature—one causal action being effective does not necessarily imply that the other actions are ineffective. In contrast, labels may have stronger implications as a result of constraints on word learning, such as mutual exclusivity (Markman, 1990) or shape bias (Landau, Smith, & Jones, 1988). For example, if an informant labels Object 1 as a "modi," this strongly implies that Object 2, which is very differently shaped, is not a modi. This would provide additional evidence against the minority, by suggesting that both objects cannot be *modis*.

Though children sided with the majority when causal actions were explicitly stated (i.e., unendorsed condition) or strongly implied (i.e., implied condition) to be mutually exclusive, they were overall less swayed by majority influence given that both actions made the toy play music. As a result, children were more likely to endorse majority testimony in a socially constructed domain (object labeling) than a nonsocially constructed domain (causal learning). However, if children were learning just from observing the cause–effect relationship, then they should have seen that both actions work and thus should not have had any preference for the majority group over the minority across pragmatic conditions. Instead, our results showed a linear trend with a decreasing slope, suggesting that children were nonetheless sensitive to the pragmatics of the informants' testimony. Overall, the data suggest that children in the causal task were learning from both causal observations and pragmatic cues.

Notably, a minority of children gave a "both" response indicating both options as correct, when asked to identify, for example, a "modi" or to make the toy play music. There are three key things to note about the trends that we found in the distribution of these responses. First, children chose both objects most often in the hidden conditions of both tasks, further indicating that children understood that informants would not comment on an object that was not present or visible. Therefore, the majority and minority were not in disagreement, they were simply providing information about different objects, and thus the majority group was providing the least amount of evidence against the minority. Hence, "both" becomes a stronger possibility.

Second, when informants were explicit (and certain) about which object they were endorsing and not endorsing, as in the unendorsed conditions, children were very unlikely to choose both causes in the causal task, and there was no endorsement of both toys in the language task. Children in this condition understood that the informants were not only saying that their object was correct but also that the other object was incorrect. Therefore, regardless of who is correct, the answer will not likely be "both."

And finally, when asked a follow-up forced-choice question, children who had previously stated that the label applied to both objects or that both causes were effective were more likely to

endorse the majority's than minority's choice. This could suggest that the majority group was used as a means of deciding which object to choose when explicitly prompted for the selection of only one object. Children's comments provide anecdotal evidence suggesting that, in some cases, children may have used the majority's endorsement as a tie breaker. Children first accepted both the majority's option and the minority's option ("They are both *modis*"), but after the forced choice, made their decision based on majority evidence ("[Yellow toy] because more people said it").

In this study, we were primarily interested in preschool-age children's ability to consider both pragmatic information and task domain when learning from testimony provided by a majority group and a minority informant. However, as reviewed in the introduction, when evaluating individual informants, children are sensitive to a variety of other cues to inform reliability, such as past accuracy (e.g., Koenig et al., 2004). Exploring children's ability to track the past accuracy of individual members of a majority and, more broadly, how children integrate individual cues to reliability and knowledge across groups of disagreeing informants is likely to be a fruitful area for future research. For instance, some previous work suggests that although preschool-age children are able to evaluate informants' source of knowledge (e.g., choosing to listen to someone who has seen where an item is versus someone who has not; e.g., Povinelli & deBlois, 1992), they may have greater difficulty reasoning about source of knowledge for groups of informants (Otsubo et al., 2017).

Also discussed in the introduction is the fact that there are a number of differences between the causal and language domains. For instance, the availability of independently observable evidence in a causal task and not in word learning is an inherent difference between these two domains. Another difference is the stronger mutual exclusivity assumption in word learning. It is possible for one or more of these differences to have led to the effect of task domain. Future research could try to further tease apart the extent to which the availability of additional evidence versus a priori differences in assumptions about how the domains operate (e.g., mutual exclusivity; conventionality) account for different inferences across these domains.

In addition, previous work on children's learning of word labels from majority information generally asked children to identify for example, "Which one is *the modi*?" (e.g., Corriveau et al., 2009). It is possible that this wording implied to children that only one object was a "modi," enhancing mutual exclusivity within the task. In our task, we sought to minimize this implication, while still remaining consistent with the testimony given in prior work and avoiding the use of the plural "modis" (which might also have pragmatic implications), by having the neutral experimenter tell children that she was unsure which ones were called *a modi* when introducing the language task. In addition, at test the experimenter asked, "Can you show me *a modi*?" so as not to imply that only one *modi* was present.

Nonetheless, it is possible that the initial introduction of the items in the language task suggested that it was more likely that only one of the objects was a "modi," enhancing mutual exclusivity. Although we cannot completely rule out this possibility, it is worth noting that children were equally likely to spontaneously give a "both" answer in the language and causal domains, indicating that they were willing to consider the possibility of more than one *modi* even in the language task. Children also did not have a preference for majority information

in the hidden condition in both domains (and the domains did not differ), suggesting that the task introduction alone did not induce an overall preference for the majority in the language task. Future work might explore whether the pragmatics of the neutral experimenter's initial statements also influenced children's subsequent inferences from the informants and, in particular, whether this might interact with the domain demands.

A somewhat unexpected result was that children in the language task were just as likely to choose the majority's object in the ignorance condition as in the implied condition. In the ignorance condition, we intended for the uncertainty about the extension of the object label to come from the speakers' (lack of) knowledge about the second option. However, in retrospect, children might have interpreted the informants' expressions of ignorance somewhat differently. For instance, they might have inferred that the majority was certain about one object having many features of a "modi" but was uncertain about the other object, not because they were unfamiliar with it but because of its more ambiguous or hard to categorize appearance. If so, this would be consistent with children making a pragmatic inference from the testimony but a different one than we had intended. Future work could clarify the pragmatic inferences children make from expressions of ignorance versus uncertainty and how they resolve ambiguities about the source of the speaker's knowledge.

Another interesting finding was that a minority of children endorsed both majority and minority testimony. When given a forced-choice question, however, these children were numerically more likely to side with the majority group. Previous work on majority bias has generally prompted the selection of only one option (e.g., forced-choice answers) and has not considered how to interpret "both" responses. Results from our study instead suggest that a close examination of situations in which children accept both the majority and the minority group's answers would be important.

In the present study, we examined *when* children trust majority informants, but understanding *why* they side with the majority group is also important. Deutsch and Gerard (1955) identified two reasons why people conform: normative conformity and informational conformity. Normative conformity results in compliance—conforming as a result of pressure and norms or the need for social acceptance yet not adopting the majority's opinions as their own. In contrast, informational conformity occurs when a person turns to others for information in an ambiguous situation or when there is uncertainty.

We primarily focused on informational conformity and took a number of steps to minimize the role of normative social influence in our tasks. Previous work has found that normative conformity is more likely in ambiguous situations (e.g., no overt goal; Sherif, 1935), with a unanimous majority (Asch, 1956), and has been found to be less frequent when the majority is not present to apply social pressure during decision making (Haun & Tomasello, 2011). Our tasks involved an overt goal (e.g., make the machine play music; identifying a "modi"), a nonunanimous majority, and our informants were presented on video and their images were not shown while children were making their decision. In addition, the structure of our experiment was consistent across all of our conditions, but children's tendency to endorse the majority varied, suggesting that normative conformity is unlikely to explain the differences observed.

It would be interesting for future work to investigate children's tendency to copy the majority when the causal task becomes more normative in order to parallel the conventional nature of the language

task. In fact, children are more likely to imitate conventional actions (based on rituals, e.g., lighting a candle to commemorate an event) than instrumental actions (goal-oriented outcome, e.g., lighting a candle to find an object in the dark; Herrmann, Legare, Harris, & Whitehouse, 2013; Legare, Wen, Herrmann, & Whitehouse, 2015). Another way in which actions can become normative is by enhancing the social benefits of conforming relative to dissenting (e.g., presence of informants; Haun et al., 2014). We might expect that as the causal task becomes more conventional, children would overall be more influenced by the majority because they assume it is the conventional way to do it, similar to the results of the language task (a domain that is inherently conventional). However, the argument for inherent domain differences would be further advanced if domain demands continue to have an effect despite manipulating the causal task to become more conventional. We are open to the possibility that differences between the task domains could be either inherent or a result of the informational structure and normativity of these domains.

### Conclusion

In conclusion, this research sheds light on how both pragmatic principles and the type of task can inform children's learning from conflicting majority and minority groups. Our results show that children are accounting for pragmatics and domain demands when deciding how to weight and interpret majority opinions. In conditions in which the testimony explicitly stated or pragmatically implied that the majority strongly disagreed with the minority informant, or that the labels or causes were mutually exclusive, children were more likely to adopt the majority's than the minority's opinion. In contrast, when the testimony had weaker implications about the strength of the disagreement, children were not more likely to rely on majority information and also considered additional evidence from their observation of cause and effect relationships in the causal task. This suggests that children do not just use a simple strategy of following the majority. Instead, they can make sophisticated inferences that go beyond the literal meaning of the testimony when evaluating testimony from multiple informants. They also consider different sources of information when available. By doing so, young children learn not only selectively from testimony but also from personal experiences as they navigate the social world.

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