Young children use statistical evidence to infer the informativeness of praise

Mika Asaba, **Emily Hembacher**, **Shi Qiu**, **Brett Anderson**, **Michael Frank**, and **Hyowon Gweon**
{masaba, ehembach, shiqiu21, brettand, mcfrank, hyo} @stanford.edu
Department of Psychology, Stanford University

Abstract

Receiving praise is not only rewarding but also informative for learners. It allows them to learn about their skills and competence even when they are uncertain or unable to judge for themselves. Not all praise is equally meaningful, however: praise from someone who praises indiscriminately is less informative than from someone who praises selectively. Do young children understand whose praise is more informative? Here we ask whether young children use covariation information to infer the informativeness of others' praise. Adults (Exp. 1) and 4-5 year-olds (Exp. 2) were more likely to trust the praise from a selective teacher whose previous praise covaried with the quality of work than praise from a teacher who indiscriminately praised independent of its quality. Exp. 3 (4 year-olds) addressed the possibility that children simply prefer a teacher who praises less often. Even for young children, praise is more than something nice; they track the informativeness of others' evaluative feedback and use it to learn about the quality of their own work.

Keywords: social cognition, praise, statistical reasoning, selective trust

Evaluative feedback from others is an important source of information for learning about ourselves. In the face of uncertainty about our abilities, traits, or the quality of our work, feedback from others can serve as a useful indicator of quality or success. For instance, if you just gave a big presentation at work and are unsure of how it went, receiving praise from a colleague (e.g., "that was a great talk!") could give you more certainty that it was good.

Not all praise is equally meaningful, however. We often interpret others' evaluative feedback in the context of the evaluator, considering her expertise, personality, or communicative goals. For instance, if you knew that your colleague only praises the best talks, you would be thrilled to have received praise; if your colleague is known to be overgenerous with praising talks, you might remain uncertain about how well you really did. The informativeness of positive evaluations can be especially ambiguous, because others may be driven not only by the goal to provide an accurate evaluation (an epistemic goal) but also by the desire to make others feel good (a social goal). Recent work suggests that adults are indeed sensitive to both the epistemic and social utility of evaluative feedback and interpret it based on speakers' communicative goals (Yoon, Tessler, Goodman, & Frank, 2016).

Praise is considered to be a useful tool to foster motivation and achievement and is common in parenting and educational practices in many societies. Because children routinely receive praise from others, understanding whose praise is more informative can help them learn better about their own skills and abilities. Despite much work on the effect of praise on children's intrinsic motivation (e.g., Henderlong & Lepper, 2002), we understand little about *how* children interpret the meaning of praise and the cognitive capacities that underlie this ability. As a first step to address these questions, we investigate whether adults (Exp. 1) and young children (4-5 year-olds; Exp. 2-3) track the informativeness of others' praise and use it to evaluate the quality of their own work. As the meaning of evaluative feedback often depends on the evaluator, in this initial evaluation we use participants' endorsement of praise as a proxy for their evaluation of the praiser.

Understanding the informativeness of praise might be challenging for young children, especially if they have difficulty differentiating informativeness and niceness. Prior work suggests that young children attribute knowledge to nice informants and endorse novel information from them even when they lack perceptual access (Lane, Wellman, & Gelman, 2013). Even school-aged children show a tendency to endorse positive assessments of an agent (Boseovski, 2012) or that agent's drawing or painting, despite negative evaluations from multiple others (Boseovski, Marble, & Hughes, 2017). In these studies however, children did not have access to any information about the work being evaluated aside from the informants' praise. In the absence of a means to evaluate the accuracy of the testimony, children might have relied more on informants' niceness. To the extent that children have a clear understanding of the actual quality of the work being evaluated, they may be sensitive to whether informants provide evaluations that are consistent with the quality of the work.

Support for this hypothesis comes from related work in epistemic trust, which suggests that 3-5 year-old children readily track the informativeness of others when a clear ground truth is available to them. Children preferentially learn from teachers who previously provided correct (versus incorrect) labels of familiar objects (e.g., Koenig & Harris, 2005; see Sobel & Kushnir, 2013 for a review), and update their evaluations of others' trustworthiness across multiple interactions (Ronfard & Lane, 2017). Beyond tracking inaccuracies, children also recognize more subtle forms of misinformation; when a teacher demonstrates only one of four functions of a toy, children penalize these teachers (Gweon & Asaba, 2017) and are less likely to trust the teacher in learning about a new toy (Gweon, Pelton, Konopka, & Schulz, 2014). These results suggest that preschool-aged children do not simply accept information from others as true of the world. Instead, they monitor others' informativeness based on the quality of their testimony or demonstrations and selectively endorse subsequent information from them. Thus, children might demonstrate similar sensitivity to the informativeness of others' praise.

Prior work also suggests that praise fosters intrinsic motivation for learning and performance when it is directed at

children's effort or the product of their work, but not when it is directed at their intelligence or ability (Mueller & Dweck, 1998; Henderlong Corpus & Lepper, 2007). The fact that children respond differently to different kinds of praise suggests that they understand praise as more than positive reinforcement (Delin & Baumeister, 1994). Indeed, researchers have proposed that the effect of praise may depend on its perceived *sincerity*; children may devalue its meaning when they see it as inflated, unjustified, or inconsistent with their self-views or reality (Brophy, 1981; Delin & Baumeister, 1994; Kanouse, Gumpert, & Canavan-Gumpert, 1981). Consistent with this idea, recent work finds that inflated praise has adverse effects on children with low self-esteem (Brummelman, Thomaes, Orobio de Castro, Overbeek, & Bushman, 2014). Yet, little empirical work has directly investigated *how* children recognize the sincerity or informativeness of praise.

One possibility is that children learn others' informativeness from repeated observations of the evaluative feedback they provide. Based on whether their evaluation appropriately covaries with the actual quality of the work (e.g., praise for high-quality work but not for low-quality work) rather than independently of its quality (e.g., praise for both high- and low-quality work), children may quickly form a model of the evaluator even from minimal evidence. Informed by prior work on children's ability to use minimal covariation data to make causal attributions about themselves or others' behaviors (Gweon & Schulz, 2011; Seiver, Gopnik, & Goodman, 2013) and children's sensitivity to teacher informativeness in epistemic domains (Sobel & Kushnir, 2013; Bonawitz & Shafto, 2016; Gweon & Asaba, 2017), we test the hypothesis that children infer others' informativeness based on statistical evidence, and use it to inform their evaluations of their work.

To this end, we chose an activity with which preschool-aged children are familiar and motivated to improve on: tracing shapes with a marker. In Experiment 1, we verify our task by showing that adult participants can differentiate between a teacher who praises all tracings (Overpraise Teacher) and a teacher who only praises tracings that are objectively better (Selective Teacher), and they use this to appropriately evaluate the quality of two hidden tracings. In Experiment 2, we designed a similar, first-person paradigm and find that 4- and 5-year-olds can differentiate between these two types of teachers and endorse the Selective Teacher's praise. In Experiment 3, we further show that children do not simply prefer teachers who provide praise less frequently.

Experiment 1: Adults

We first verified that adults can track agents' patterns of praise and infer their informativeness. Adults saw two teachers: a teacher whose previous pattern of praise appropriately co-varied with the actual quality of the tracings (Selective Teacher) and a teacher who previously praised all tracings independently of their quality (Overpraise Teacher). Given two unseen tracings, each endorsed by different teachers, we predicted that adults would judge the one endorsed by the Se-

lective Teacher to be better in quality than the one endorsed by the Overpraise Teacher. As an exploratory measure, we asked which teacher was "trying to be nice" to see whether adults would distinguish the teacher's goal to be informative from her goal to be nice or polite (Yoon et al., 2016).

Methods

Participants Eighty-six adults (38 female, M_{Age}(SD) = 36.6(11.9), range: 21-71) were recruited from Amazon's Mechanical Turk. An additional 14 subjects were excluded for failing one or both memory check questions.

Stimuli Images of "good" and "bad" tracings (i.e., a marker tracing that was reasonably aligned or misaligned with the template shape, see Fig. 1A) and two videos of teacher-student interactions were used (Fig. 1B). Both videos showed a child ("Johnny") with his back facing the camera, and a teacher sitting across a table facing the child. Six tracings were placed in a row on the table; there were 3 good tracings and 3 bad tracings, in alternating order (similar in quality as those used in the *Warm-up Phase*). Each video had a different set of six tracings. The same child appeared in both videos, but one featured "Teacher Jane" who wore a green shirt and the other featured "Teacher Susan" who wore a red shirt.

Procedure In the *Warm-up Phase*, participants were shown two tracings that clearly differed in quality (Fig. 1A) and were asked to indicate which one was better; participants who answered incorrectly were excluded from analyses.

In the *Teacher Introduction Phase*, participants watched two videos. In both videos, Johnny first told the teacher that he made the tracings and really wanted to know which of his tracings were good. The teacher then evaluated the tracings one at a time from right to left. In the Overpraise Teacher video, the teacher provided positive, undifferentiated feedback ("Wow, that's great!") for all six tracings and placed a colored star sticker on each tracing that matched the color of her shirt (see Fig. 1B). In the Selective Teacher video, the teacher provided positive feedback on the good tracings ("Wow, that's great!") and put matching-colored stickers on them, while giving neutral feedback ("Hm, this one's okay!") for the three bad tracings without giving stickers. Both teachers maintained a positive tone for both types of feedback; teacher identity, pattern of praise, and order of presentation were all counterbalanced. After each video, participants were asked how many tracings the teacher said were great. Subjects who failed to correctly answer these memory check questions ("3" for the Selective Teacher and "6" for the Overpraise Teacher) were excluded from analyses.

Finally, in the *Test Question Phase*, participants were shown a picture of another student (Kristen) who made two tracings and two envelopes, each of which contained one of her tracings. Participants were told that the Selective Teacher saw only the tracing in one of the envelopes and praised it (e.g., "Teacher Jane said this tracing is great"), and the Overpraise Teacher saw only the tracing in the other envelope and

praised it ("Teacher Susan said this tracing is great"). Participants never saw Kristen's actual tracings, only the envelopes with stickers that indicated which teacher praised the tracing. Participants were asked: "Kristen is going to bring one of her tracings to a contest. Which tracing should she bring?" Additionally, participants were asked: "One of the teachers wanted to be nice. Who was trying to be nice?"

Results and Discussion

Our primary question was whether adults use teachers' prior patterns of praise to evaluate the informativeness of subsequent praise. As predicted, participants overwhelmingly chose the tracing praised by the Selective Teacher (87.2%, $p < .001$, Binomial Test, Figure 1D). Additionally, adults inferred niceness as the Overpraise Teacher's communicative goal; a majority of participants chose the Overpraise Teacher as the one who was *trying* to be nice (93.0%, $p < 0.001$, Binomial Test). These results suggest that adults readily detect the differences in the informativeness of evaluative feedback from minimal covariation data, and use it to inform their decisions about the quality of an unseen product.

Experiment 2

In Experiment 2, we investigated whether 4- and 5-year-old children are also sensitive to the informativeness of others' praise. The design was almost identical to Experiment 1, except that to increase engagement and motivation, children themselves completed two tracings to be used in the final Test Question. If children can infer the informativeness of praise based on each teacher's prior history of evaluating others' work, children would choose the envelope praised by the Selective Teacher, as in Experiment 1. However, if children prefer to accept information from informants who are perceived as positive or friendly, they would choose the tracing praised by the Overpraise Teacher.

Methods

Participants Forty 4- and 5-year-olds (19 female, M_{Age}(SD) = 4.9(0.4), range = 4.1 - 5.9) were recruited from a local preschool.[1] An additional 5 children were tested but excluded due to failure on the warm-up or memory questions.

Stimuli Stimuli were the same as those from Exp. 1. Additionally, two 8.5"x11" tracing templates (a circle and either an overlapping triangle or rectangle) were used for children to make their own tracings. The tracings in the *Warm-up Phase* were presented on laminated sheets of paper, and videos were presented on a 13" Macbook Pro laptop. We also used printed pictures of the teachers and Johnny, two manila envelopes, and star-shaped red and green stickers.

Procedure Children were tested in a private room in a preschool. During the *Warm-up Phase*, the experimenter first explained what tracing is: "The goal of tracing is to stay as

close to the lines as possible" and demonstrated tracing a rectangle for the child. Then, the child traced the two templates, and the experimenter put each tracing away into an envelope such that the child could not see the tracing for the remainder of the session. Children were shown two pairs of tracings (similar in quality to those in Exp. 1) and were asked to indicate which one was better. Only children who passed both trials were included in the analyses.

In the *Teacher Introduction Phase*, children were shown a picture of a student, Johnny. They were told that Johnny was working on his tracings earlier and wanted help figuring out which of his tracings were good, because he wanted to show them to his class later. Children then watched the same Selective Teacher and Overpraise Teacher videos as in Exp. 1. After each video, children saw a still frame of the video (with no stars on the tracings) and were asked which tracings the teacher said were great. If children missed a tracing or incorrectly pointed to a tracing that was not praised by the teacher, they watched the video again and the experimenter asked the same memory check question. Those who failed the memory check even after watching the video again were excluded from analyses.

In the *Test Question Phase*, the experimenter told the child that Teacher Jane and Teacher Susan were nearby and could give feedback on the child's tracings from earlier. The experimenter left the room with the envelopes containing the child's tracings and returned after 15 seconds with stickers attached to the envelopes. The experimenter pointed to the envelope with a green sticker and placed a photo of Teacher Jane next to it, and said: "Teacher Jane looked at this tracing and said that this one is great." She then pointed to the other envelope (with a red sticker and Teacher Susan's photo) and said: "Teacher Susan looked at this tracing and said that this one is great" (teacher order counterbalanced). Finally, with the tracings still in the envelopes, the experimenter said: "Now you can bring back your best tracing to show your teacher! Which one do you think is the best?" Children responded by pointing to one of the envelopes. As an exploratory measure, children were asked, "Which teacher was trying to be nice?"

Results and Discussion

As in Exp. 1, our main question was which tracing children thought was better. As predicted, children were significantly more likely to choose the tracing praised by the Selective Teacher (72.5%, $p = 0.006$, Binomial Test). To investigate whether children's age predicted their choice, we fit a logistic regression model: `Tracing choice ~ Age in Months + (1 | Subject)`. Children's age did not predict their choice of tracing ($B = 0.30$, $z = 0.34$, $p = 0.73$).

These results suggest that children were more likely to endorse the praise given by a teacher who had previously provided selective praise that covaried with the actual quality of the tracings over the praise given by a teacher who had indiscriminately praised all tracings. However, when asked which teacher was trying to be nice, children did not show a preference for either teacher (55%, $p = 0.64$, Binomial Test); it is
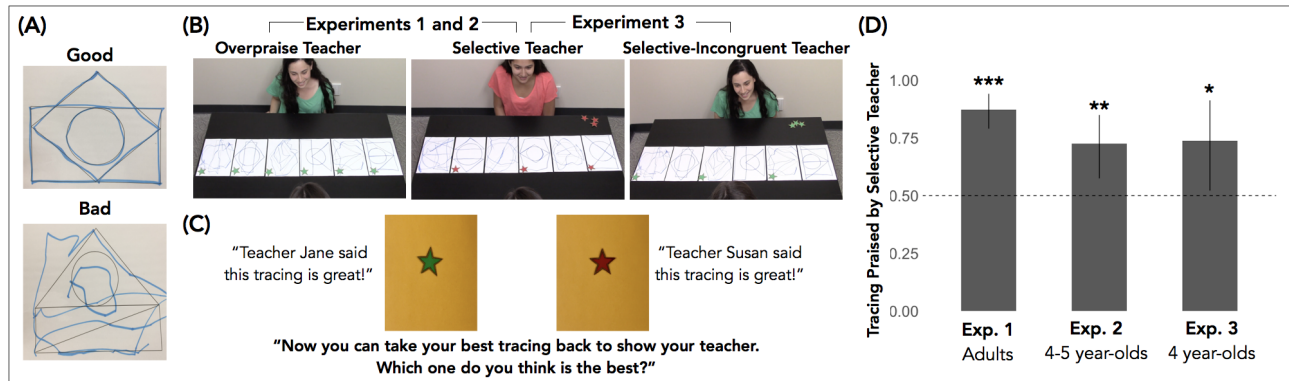
Figure 1: (A) Examples of good and bad tracings that participants saw in the warm-up questions and teacher videos for Experiments 1-3. (B) Teacher videos shown in Experiments 1-3. (C) Set-up and critical question for Experiments 2-3. (D) Results for Exp. 1-3 (* $p < .05$, ** $p < .01$, *** $p < .001$). Error bars are 95 percent confidence intervals.

possible that children's responses to this exploratory question were influenced by their answer to the Test Question.

Note however that the patterns of the two teachers' praise differed in two important ways. First, the feedback (positive versus neutral) appropriately co-varied with the actual quality of the tracings or it was indiscriminate; the Selective Teacher provided praise that was *congruent* with the tracings' quality, whereas the Overpraise Teacher praised all tracings independent of their quality. Second, the feedback also differed in the *frequency* of praise; the Selective Teacher praised only 3 of the 6 tracings while the Overpraise teacher praised all 6. Thus, it is possible that children have a simple heuristic that praise from someone who rarely praises is more informative. We addressed this alternative explanation in Experiment 3.

Experiment 3

In Experiment 3, we asked whether children distinguish between teachers who provided positive feedback to the good tracings and neutral feedback to the bad tracings (Selective Teacher, as in Exp. 1 & 2) from a teacher who provided positive feedback to the bad tracings and neutral feedback to the good tracings (Selective-Incongruent Teacher). Because the frequency and the overall valence of their feedback was matched, the critical difference was whether their feedback was congruent or incongruent with the actual quality of the drawings. We predicted that if children track whether the content of feedback appropriately co-varies with the quality of the drawings, they should trust the evaluation of the Selective Teacher more than the evaluation of the Selective-Incongruent Teacher. Given the absence of an age trend in Exp. 2, we limited our recruitment to 4-year-olds.

Methods

Participants Twenty-three 4-year-olds (15 female, M_{Age}(SD) = 4.6(0.3), range = 4.0 - 4.9) were recruited from a university preschool. An additional 5 subjects were tested but excluded due to failure on the warm-up or memory check questions.

Stimuli and Design Stimuli were identical to Experiment 2 except the Overpraise Teacher video was replaced with the Selective-Incongruent Teacher video. The Selective-Incongruent Teacher was similar to the Selective Teacher but provided praise in the opposite way: she praised the bad tracings and gave neutral response to the good tracings.

Procedure The procedure was identical to Experiment 2.

Results and Discussion

Our main question was whether children would endorse the praise from the Selective Teacher, even when the relative frequency of the two teachers' praise was matched. Indeed, children were more likely to choose the tracing praised by the Selective Teacher than the one praised by the Selective-Incongruent Teacher (73.91%, $p = 0.03$, Binomial Test).[2] We also fit the same logistic regression model as in Exp. 2 (Tracing choice ~ Age in Months + (1 | Subject)), and found that children's age did predict their choice of tracing (B = -6.28, z = -2.05, p = 0.04).

These results suggest that children are not simply responding to the relative frequency of praise; they are sensitive to whether the teacher provides feedback that appropriately co-varies with the actual quality of tracings. Unlike Exp. 2 (and despite the narrower age range), we did find a small but significant effect of age. Given that there was no effect of age in Exp. 1, further work is needed to better understand how this capacity develops throughout the early childhood years.

General Discussion

Across three experiments, we examined whether adults and children infer the informativeness of others' praise, and use it to evaluate their own or others' work when they themselves are unable to judge. Experiment 1 verified that adults reliably

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[2]As for the exploratory question ("who was trying to be nice?"), we did not predict a pattern to emerge as neither teacher was trying to be nice; children's responses were not different from chance (60.87%, p = 0.405, Binomial Test).

distinguish a teacher who selectively praised from a teacher who indiscriminately overpraised. Experiment 2 provides support for our main hypothesis: Even 4-5 year-old children distinguish between these two teachers and use their relative informativeness to evaluate the quality of their own work. Experiment 3 further suggests that children's responses are not driven by the simple heuristic that people who praise rarely are more informative; when the frequency and the overall valence of praise were matched, 4-year-olds still endorsed the praise from the teacher who had previously provided feedback that was both selective and congruent with reality.

Praise is a useful source of information for learning about our skills and abilities; determining whose praise to trust or discount is critical for effectively learning about the self. Prior work has found that children hold strong beliefs about their competence, predicting that they will perform better in the future than they are able to (Schneider, 1998) and judging that they have performed well when they have not (Hembacher & Ghetti, 2014). We do not know whether this bias about their own abilities would cloud their evaluation of the informativeness of feedback directed at them (not another student). Our experiments do show, however, that they were able to *apply* feedback to make predictions about their own work – thus their optimism did not completely overpower their ability to integrate others' prior feedback into their assessments of their own work. Even though children constantly receive praise, they rationally decided whose praise to trust based on the past history of the evaluator.

These results are consistent with a growing body of literature that suggests children reason about others' informativeness based on the information they provide (Sobel & Kushnir, 2013; Gweon & Asaba, 2017). Going beyond using facts about the physical world (e.g., labels of objects, causal functions of artifacts), children also used information about the quality of work (e.g., quality of tracings) to decide whether or not to trust someone's evaluative feedback. More specifically, children's inferences were based on the statistical dependence between the pattern of praise and the quality of the work being praised. Thus, children's early-emerging sensitivity to statistical information (Gweon & Schulz, 2011) might also support inferences about others' informativeness.

Recent work suggests that adults are sensitive to the presence of competing goals in communicative contexts (e.g., being informative vs. being polite, Yoon et al., 2016). In line with this finding, adults in our study readily identified which teacher was trying to be nice. However, this exploratory question about niceness did not yield informative results from children; it is possible that they did not distinguish "trying to be nice" and "being nice,"[3] or perseverated based on their response to the Test Question. Future work might examine whether children infer different communicative goals of evaluators from the statistical patterns of their praise.

Just as evaluators may have competing social goals to be

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[3]An earlier pilot with adults suggested that the Selective Teacher could be considered (genuinely) nice for being informative.

informative or nice, learners also have reasons to seek informative feedback or warm compliments from others. Our study emphasized the learner's goal by explaining that they had to choose a tracing to enter into a contest (Exp. 1) or show to their teacher (Exp. 2 & 3). Yet, learners may have diverse goals in approaching others for feedback; they could want honest evaluation of their performance, or affirmation of their efforts to *feel better* about themselves. An open question is whether young children differentially weight praise based on their own goals, and how this tendency might change with age. It is possible that younger children generally seek more affirmation than evaluation, but their goal might also vary depending on their competence in the domain and the relative difficulty of the task; for instance, learners might prefer encouragement when they are struggling on new or difficult tasks. The kind of feedback children seek might also depend on their relationship to the evaluator, desiring more affirmation from parents and expecting more objective evaluations from teachers. Future work might ask how children actively choose which teacher to approach depending on their goals (e.g., informativeness versus affirmation).

In the current study, children observed repeated instances of praise from two teachers whose praise was clearly aligned (Selective Teacher) or misaligned (Overpraise and Selective-Incongruent Teacher) with the quality of the tracings. In order to ensure well-controlled presentation of two teachers who varied only in their pattern of praise, children watched videos of teachers instead of seeing real teachers praise their own (or their peers') work. In real life, however, children's observation of evaluative feedback is often noisier, and unfolds in a complex social environment where both the evaluators and the students must navigate multiple competing goals. Therefore, even though these results are suggestive of an early-emerging sensitivity to the informativeness of praise, further work is needed to better understand how such sensitivity might manifest in real-world contexts. Furthermore, given that our participants were from a university preschool where children receive ample social support from adults, future work might ask whether our findings generalize to a broader population of preschoolers who might experience varying levels of praise, encouragement, and support.

The ability to make an independent assessment of the quality was critical for success in our task. Indeed, if you do not know how good a tracing is, you cannot tell whether a teacher's feedback is appropriate. In our paradigm, we used clearly good or bad tracings and ensured that all children could accurately assess their quality. However, we rarely have absolute certainty about the quality of our own work. When do children rely on their own assessment to infer others' informativeness, and when do they rely on others' evaluative feedback to inform their own assessments? One possibility is that children integrate their own certainty and others' informativeness to learn about themselves (i.e., did I do well?) or about the evaluators (i.e., is this person informative?). The presence of a majority opinion (Burdett et al., 2016) or con-

flicting evaluations (Bridgers, Buchsbaum, Seiver, Griffiths, & Gopnik, 2016) may further influence these decisions.

Constructive feedback provides insights into learners' strengths and weaknesses, and guides their future learning to maximize opportunities for growth. Our results suggest that the ability to seek constructive feedback might start early in life. Even for young children, praise is more than something nice; they track the informativeness of others' evaluative feedback and use it to infer the quality of their own work.

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All data and code for these analyses are available at
`https://github.com/masaba/uncertainpraise`

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