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Young Children use Supply and Demand to Infer Desirability

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Abstract

In four experiments, we show that young children (total $N = 290$) use information about supply and demand to infer the desirability of resources. In each experiment, children saw scenarios about sandwiches from different shops, which varied in supply (number of sandwiches produced for the day) and demand (number of customers attracted). In Experiments 1 and 2, 5-6-year-olds gave higher desirability ratings for sandwiches from shops with greater than lesser demand when supply was held constant. In Experiment 3, 5-7-year-olds gave higher desirability ratings for sandwiches from shops with less than more supply when demand was held constant. Finally, in Experiment 4, 5-6-year-olds were more likely to judge that sandwiches came from a good shop (rather than from a bad one) when demand exceeded supply, than when supply exceeded demand. Together, the findings reveal a way that children can infer how desirable resources are, without needing to incur the costs that would normally be required to obtain and sample the resources themselves.

Keywords: supply and demand; desirability; costs; folk economics; economic concepts; quality.

Young Children use Supply and Demand to Infer Desirability

Supply and demand are informative about the desirability of goods and resources. We expect good bread from a bakery that regularly sells out, leaving customers empty-handed and disappointed. But our expectations are lower for a bakery that produces more than it can sell and offers plenty of day-old bread at a discount. The line may be longer and the prices may be higher at the bakery where demand outstrips supply. But if we care about good bread, these costs may be worth it.

In this paper, we investigate whether young children use supply and demand to infer the desirability and quality of resources. This ability is important because acquiring information about desirability can be costly. For example, though we could learn whether the bread from the bakeries is any good by tasting some, this would require waiting in line and paying! Further, by investing this time and money at one bakery, we lose the opportunity of obtaining better bread elsewhere. Such costs are a major reason we seek information about desirability *before* obtaining or trying a resource. Considering supply and demand is valuable, then, because it may provide a low-cost way for children to evaluate resources, without requiring them to access the resources themselves.

Investigating this ability may contribute to our understanding of how children assess the value, quality, and desirability of objects. Besides basing such assessments on objects' perceptible features, children also consider object history (for a recent review, see Gelman & Echelbarger, 2019). For example, children highly value objects previously owned by famous individuals (Frazier & Gelman, 2009; Gelman, Frazier, Noles, Manczak, & Stilwell, 2015), objects acquired or created in distinctive ways (Pesowski & Friedman, in press), and objects created by children themselves (Marsh, Kanngiesser, & Hood, 2018). Information about supply

and demand is similar to these factors in allowing children to sidestep the perceptible features of objects. But information about supply and demand is also distinct because it can concern the present, and need not concern the past.

Some research has examined how children understand supply and demand, but not in connection with inferences of desirability. Instead, this research mainly investigated children's judgments about sales and prices (e.g., Berti & Grivet, 1990; Leiser & Halachmi, 2006; Thompson & Siegler, 2000). This research shows that children understand the effects of manipulating demand years before they understand the effects of manipulating supply. For example, 4-year-olds understand that increasing demand will lead to more sales at a lemonade stand, but 6-year-olds do not yet grasp that increasing competitors (and hence supply) will reduce sales at the stand (Siegler & Thompson, 1998). On the basis of such findings, we might expect that children will have difficulty bringing information about supply and demand together to infer the desirability of resources.

Other research has looked at how manipulations of supply affect children's preferences. This research shows that young children do not share adults' preference for scarce resources over abundant ones. Instead, children under the age of 6 or 7 prefer abundant resources or have no preference between scarce and abundant resources (Diesendruck, Chiang, Ferera, & Benozio, 2019; Echelbarger & Gelman, 2017; John et al., 2018). These findings again cast doubt on the likelihood that children will be able to incorporate information about supply into assessments of desirability. Yet we cannot be certain as no studies have examined whether supply and demand together affect children's inferences of desirability. So it remains possible that children might use supply and demand to make these inferences.

We conducted four experiments investigating young children's ability to use supply and demand to infer desirability. In each experiment, children made judgments about the tastiness of sandwiches from various shops, which differed in the number of sandwiches they produced (supply) and the number of customers (demand) they attracted. Sandwiches can vary considerably, and so we felt that children would readily recognize that the sandwiches could differ in tastiness.

Across the experiments, we varied the experimental approach. This was important for testing whether children consider *both* supply and demand, and for assessing whether their abilities to consider these factors is robust to at least some methodological variations. In the first three experiments, children saw individual sandwich shops, and used a scale to rate the tastiness of the sandwiches from each shop. In Experiments 1 and 2, we manipulated demand across conditions (between-subjects in Experiment 1, and within-subjects in Experiment 2) while holding supply constant. In Experiment 3, we manipulated supply (within-subjects) while holding demand constant. Finally, in the fourth experiment, we manipulated supply and demand together (within-subjects) and examined whether children could use this information to judge whether sandwiches had been made by a good shop or a bad one.

Experiment 1

In this experiment, five and six-year-olds saw vignettes about shops with high demand for their sandwiches or vignettes about shops with low demand.

Method

Participants. We tested 80 5-6-year-olds ($M = 5;11$ [years; months], range = 5;0-6;11, 42 females). In this experiment, we aimed to test 20 children at each age-in-years per between-

subjects condition.¹ In the subsequent experiments, which all used within-subjects designs, we raised this number to 30 children at each age-in-years. This shift in sample sizes corresponded with changes to our lab policy regarding stopping rules for developmental studies.

In all experiments, children were recruited from and tested at daycares, preschools, and elementary schools in the Region of Waterloo. Residents of the region are predominantly middle-class; 81% of residents are White, and Chinese and South Asians residents are the main visible minority. We tested different children in each experiment. All studies were approved by the Office of Research Ethics at the University of Waterloo under project #30395, “Social Understanding in Children”.

Procedure. Children first completed a warm-up to give them practice rating tastiness.² They were shown a row of five smiley-face style faces ranging from very happy to very sad, and were told that the happiest face meant “very yummy” and the saddest face meant “very yucky”. Children then used this scale to indicate the tastiness of three familiar foods (onion, cupcake, spoonful of mustard; e.g., “Look, here’s an onion. How tasty is this onion?”). In all experiments, all visual materials were shown on a laptop computer. Children responded by pointing, and the experimenter immediately noted their responses on a testing sheet; the testing sessions were not audio- or video-recorded.

The main task then began. Figure 1 shows sample slides and scripts of test trials from all experiments; see the online Supplemental Materials for videos illustrating experimental procedures. Children were first shown a picture of a cartoon town, and told “Look, here’s a town.

¹ After data collection was complete, we realized that one child initially categorized as aged 5 was actually aged 6.

² We implemented the warm-up after the first 13 children had been tested. If these children are excluded, the main effect of condition remains significant, $p < .001$, and the main effect of age becomes marginal, $p = .058$.

And you know what? In this town, there are lots and lots of sandwich shops. Some of the shops make very tasty sandwiches and some of the shops make very yucky sandwiches.” Next, they

Experiment 1

High demand

Low demand

Look, here's one of the sandwich shops in this town. In the morning, the shop makes lots and lots of sandwiches. And at lunchtime, [lots and lots of / only a few] people come to buy sandwiches. So, at the end of the day, the shop [has only a few / lots and lots of] sandwiches left. I have a question for you: How tasty are the sandwiches from this shop?

Experiment 2

High demand

Low demand

Look, here's [another] one of the sandwich shops in this town. In the morning, the shop makes these sandwiches to sell today. And at lunchtime, here are all the people who came to buy sandwiches. No other people came to buy sandwiches afterwards. And look, here are all the sandwiches left at the end of the day that nobody bought. I have a question for you: How tasty are the sandwiches from this shop?

Experiment 3

Greater demand

Greater supply

Look, here's [another] one of the sandwich shops in this town. In the morning, the shop makes these sandwiches to sell today. And at lunchtime, here are all the people who came to buy sandwiches. No other people came to buy sandwiches afterwards. I have a question for you: How tasty are the sandwiches from this shop?

Experiment 4

Greater demand

Look, one of the shops made these sandwiches and here are all the people who came to buy the sandwiches. Which shop made these sandwiches?

Figure 1. Sample materials and scripts from test trials in each experiment. In Experiments 1-3, children responded using a final slide showing 5 faces ranging from very happy to very sad.

were told about a sandwich shop in the town. The shop made lots of sandwiches in the morning (depicted via 20 identical-looking sandwiches), and customers came to buy the sandwiches at lunch time. Here the task varied across two between-subjects conditions; equal numbers of children were randomly assigned to each condition. In the high-demand condition, 18 customers lined up for sandwiches, and 2 sandwiches remained at the end of the day. In the low-demand condition, conversely, only 2 customers lined up, and 18 sandwiches remained. In each condition, the testing script referred to whether there were many or few customers, and whether many or few sandwiches were left. Finally, children were asked, “How tasty are the sandwiches from this shop?” and indicated their ratings on the scale used in the warm-up exercise; ratings were coded from 2 (most positive) to -2 (most negative).

Results and Discussion

The data from all experiments and the syntax used in all analyses are available online at this [link to OSF](#). We entered children’s ratings into a generalized linear model (ordinal logistic data) with the predictors demand (high, low) and age-in-months (centered, and entered as a covariate). As shown in Figure 2 (left), there was a main effect of demand, Wald $\chi^2(1) = 19.86$, $p < .001$; children gave more positive ratings in the high-demand than in the low-demand condition. There was also a main effect of age, Wald $\chi^2(1) = 3.85$, $p = .050$, in which older children gave less positive ratings overall than did younger children. There was no interaction, though, between demand and age, $p = .776$.

These results suggest that 5-6-year-olds use supply and demand relations to infer the desirability of goods. We also found that with age, children became more likely to give less positive ratings. This effect could result from a developmental increase in willingness to use the negative end of the scale, or from development in children’s understanding that sandwiches are

not always tasty. However, this developmental effect might be unreliable, as it was not replicated in the other experiments.

Figure 2. Children’s ratings in Experiments 1 (left) and 2 (right). Ratings ranged from 2 “Very yummy” to -2 “Very yucky”. Colored bands show 95% confidence intervals; points are jittered to avoid over-plotting.

Experiment 2

The findings from the first experiment suggest that 5-6-year-olds use supply and demand to infer desirability. In this experiment, we sought to replicate the finding using a within-subjects design, while also reducing the information that children could use. In the first experiment, the script mentioned whether many or few customers came to the shop, and whether many or few sandwiches were left over. In the present experiment, this information was removed from the script. Also, the first experiment offered children two cues about demand for the sandwiches: 1) the number of customers who visited the shop, and 2) the number of leftover sandwiches. In the

present experiment, we held the number of customers constant, and only varied the number of leftover sandwiches. This approach distinguishes apparent popularity (i.e., number of visitors) from actual demand (i.e., goods actually purchased).

Method

Participants. We tested 60 5-6-year-olds ($M = 6;0$, range = 5;0-6;11, 29 females).

Procedure. Children completed the warm-up exercise (as in Experiment 1) and were then told about the town and its sandwich shops. Next, they listened to two stories (order counterbalanced), each about a different sandwich shop. In each story, the sandwich shop made 24 sandwiches in the morning, and 12 customers came to buy the sandwiches at lunchtime. The stories differed in the number of sandwiches left over at the end of the day: In the high-demand story, 2 sandwiches were left over; in the low-demand story, 18 were left over. The accompanying script was identical across both versions of the story, and so the only factor that differed across the two conditions was the number of leftover sandwiches (and by extension the number that must have been purchased). After each story, children rated the tastiness of the sandwiches at each shop using the scale with five faces.

Results and Discussion

We entered children's ratings into a generalized estimating equations (GEE) model (ordinal logistic regression, independent correlation matrix) with the predictors demand (high, low) and age-in-months (mean centered). As shown in Figure 2 (right), there was a main effect of demand, Wald $\chi^2(1) = 14.04$, $p < .001$. As in the first experiment, ratings were greater in the high-demand condition than in the low-demand condition. There was no significant effect of age and no significant interaction between condition and age, $ps \geq .126$. These results again suggest that 5-6-year-olds use supply and demand to infer quality.

Experiment 3

In the experiments so far, the conditions varied in demand for the sandwiches. In this experiment, we instead manipulated supply across conditions, while holding demand constant. To focus on supply, we modified the task so that children were not shown how many resources were left over. In this experiment, we also expanded the age range to include children aged 7. We did this because previous studies consistently found that children only become sensitive to information about supply years after they become sensitive to information about demand (e.g., Leiser & Halachmi, 2006; Thompson & Siegler, 2000). Hence, we were uncertain whether 5-6-year-olds would respond differently across conditions. To make variations in supply especially salient, we manipulated it so that it either exceeded demand (greater supply) or was exceeded by demand (greater demand).

Method

Participants. We tested 90 5-7-year-olds ($M = 6;5$, range = 5;0-7;11, 40 females).

Procedure. Children completed the warm-up exercise and were then told about the town and its sandwich shops. Next, they listened to two stories (order counterbalanced across children): greater-demand and greater-supply. In the greater-demand story, a shop made 5 sandwiches in the morning and 10 customers came to buy sandwiches at lunchtime; in the greater-supply story, a different shop made 20 sandwiches in the morning, and again 10 customers came to buy sandwiches at lunch. As in the previous experiment, both stories used the same script (i.e., the differences were entirely visual). After each story, children rated the tastiness of the sandwiches using the scale with five faces.

Results and Discussion

We entered children's ratings into a GEE model (ordinal logistic regression, independent correlation matrix) with the predictors condition (greater-demand, greater-supply) and age-in-months (mean centered). As shown in Figure 3, there was a main effect of condition, Wald $\chi^2(1) = 25.52, p < .001$, but no significant effect of age and no significant interaction between condition and age, $ps \geq .157$. The main effect of condition resulted because children gave higher ratings when demand exceeded supply, compared with when supply exceeded demand.

These findings again suggest that children use supply and demand to infer quality, even though we manipulated supply in this experiment. Children's success is noteworthy given earlier work suggesting that young children are often insensitive to manipulations of supply (e.g., Leiser & Halachmi, 2006; Thompson & Siegler, 2000).

Figure 3. Children's ratings in Experiment 3. Ratings ranged from 2 "Very yummy" to -2 "Very yucky". Colored bands show 95% confidence intervals; points are jittered to avoid over-plotting.

Experiment 4

The experiments so far show that children use supply and demand to infer desirability. These experiments used somewhat different methods from one another (e.g., between-subjects design in Experiment 1 vs within-subjects design in Experiment 2; demand manipulated in Experiments 1 and 2 vs supply manipulated in Experiment 3). Yet the methods also share much in common. For example, each experiment manipulated just one factor across conditions, and children in each experiment responded using the same scale.

In this final experiment, we employed somewhat different methods. Our primary motivation was to ensure that children's sensitivity to supply and demand is robust to methodological variation—we wanted to be sure that the previous experiments had not just hit on narrow circumstances where children happen to succeed. Hence, whereas the previous experiments manipulated supply and demand separately, this experiment manipulated both factors together. Whereas the previous experiments each featured just one numerical comparison (e.g., 20 sandwiches with either 18 or 2 customers), this experiment featured numerical comparisons with higher numbers of customers and resources, and comparisons with lower numbers. Finally, whereas the previous experiments had children rate the quality of sandwiches using a scale, this final experiment assessed a different kind of judgment. Specifically, we tested whether children could use supply and demand to infer which of two shops had produced the sandwiches—a shop that makes good sandwiches, or a shop that makes bad ones.

Method

Participants. We tested 60 5-6-year-olds ($M = 6;0$, range = 5;0-6;11, 25 females).

Procedure. Children were shown pictures of two sandwich shops, one nicer-looking than the other. They were told that the nicer-looking shop makes very tasty sandwiches and that the other shop makes sandwiches that “aren’t very good”. To help children remember this information, there was a thumbs-up picture next to the nicer shop, and a thumbs-down picture beside the other shop. Children were told they would be shown sandwiches and customers, and would be asked to guess which shop had made the sandwiches. Children then completed four test trials. In each trial, they were shown a group of sandwiches (“Look, one of the shops made these sandwiches to sell”) and a group of customers (“And here are all the people who came to buy the sandwiches”), and then were asked, “Which shop made these sandwiches?”

Across the four test trials, we manipulated two factors within-subjects: 1) whether demand exceeded supply (more customers than sandwiches) or supply exceeded demand (more sandwiches than customers); and 2) whether the numbers of customers and sandwiches were relatively high (e.g., 20 customers or sandwiches, and 5 of the other) or low (8 and 2). The four trials were given in either of two orders ([customers:sandwiches] 5:20, 8:2, 20:5, 2:8 and 20:5, 2:8, 5:20, 8:2).

Results and Discussion

We entered children’s judgments that sandwiches were from the better shop into a GEE model (binary logistic, independent correlation matrix) with the predictors condition (greater demand, greater supply), number of customers and sandwiches (high, low), and age-in-months (mean centered). As shown in Figure 4, there were main effects of condition, Wald $\chi^2(1) = 14.16, p < .001$, and number, Wald $\chi^2(1) = 19.44, p < .001$. Children were more likely to judge that sandwiches came from the better shop when demand exceeded supply (i.e., compared with when supply exceeded demand) and when there were more customers and sandwiches (i.e.,

rather than less). There was a marginal effect of age, Wald $\chi^2(1) = 3.01, p = .083$, but no interactions reached significance, $ps \geq .176$.

These findings again suggest that children use supply and demand to infer quality, and that children do so even when both factors are manipulated across trials. It is also noteworthy that children were overall more likely to judge that sandwiches came from the better shop when the numbers of customers and sandwiches were higher. As we show in the Supplementary Materials, this effect of number stemmed from variation in the number of customers, rather than from variation in the number of sandwiches available.³ Perhaps this is unsurprising. Demand (or popularity) may serve as a stand-alone cue for desirability. But low supply does not necessarily imply desirability—unless there is demand for a scarce item, there may be little reason to expect it to be desirable (for related findings from adults see Verhallen, 1982, 1994 and Worchel, Lee, & Adewole, 1975).

³ We are grateful to an anonymous reviewer for pointing out this finding, which we had initially overlooked.

Figure 4. Children's judgments that the sandwiches were made by the better shop (rather than the worse one) in Experiment 4. Colored bands show 95% confidence intervals; points are jittered to avoid over-plotting.

General Discussion

Across four experiments, we found that children aged 5 years and older use supply and demand to infer desirability. We found that children made these inferences when we manipulated demand across conditions, supply across conditions, and both factors. They made these inferences in experiments using both between- and within-subjects designs, and both when rating the relative desirability of resources on a scale, and when indicating whether resources came from a high- or low-quality source.

These findings advance knowledge of factors that affect children's valuations of objects. Children's valuations sometimes depend on objects' appearances (i.e., attractive and interesting-looking objects are preferred over unattractive or boring looking ones; e.g., Fawcett & Markson, 2010; Ma & Xu, 2011; see Webley, 2005 for a review of other factors affecting older children's valuations of objects). But young children also consider less obvious factors that pertain to objects' histories. For example, children highly regard objects previously owned by famous individuals (Frazier & Gelman, 2009; Gelman et al., 2015), much as adults value objects once possessed by celebrities (e.g., Marchak & Hall, 2017; Newman & Bloom, 2014). Like object history, information about supply and demand does not pertain to how attractive or interesting an object or resource looks. But unlike object history, information about supply and demand can be readily gleaned by examining an environment. Glancing in the window of a bakery or restaurant is often enough to give a sense of the relative demand for its products.

Children's success in considering both supply and demand contrasts with earlier findings suggesting that young children are sensitive to manipulations of demand, but not supply (Berti &

Grivet, 1990; Leiser & Halachmi, 2006; Siegler & Thompson, 1998; Thompson & Siegler, 2000). One explanation for this difference is that our study investigated inferences about the desirability of foods, whereas previous studies investigated other kinds of inferences (e.g., about sales and prices) for which the relevance of supply might be less obvious. The contrast in findings could also stem from methodological differences. For example, most previous studies conveyed information about supply by describing the number of vendors that were selling resources, but (probably) without providing a visual representation of the number of items available. So perhaps the visual depictions in the current study made it easier for children to consider supply (for somewhat related findings with older children, see Ruggeri, Vagharchakian, & Xu, 2018). These accounts are only speculative, though, as there were many other differences between the present study and those earlier ones (e.g., differences in wording of test questions; differences in demographics of participants).

Regardless, one question raised by our findings is *how* children use supply and demand to infer desirability. The findings suggest that children consider multiple factors, and are not restricted to relying on simple rules. In contrast with the studies where young children considered demand but not supply (e.g., Leiser & Halachmi, 2006), we found that children are sensitive to manipulations of both factors. Moreover, children appeared to be sensitive to multiple cues to demand—they were influenced by information about how many customers visited a store, and by information about how many items for sale were left over. Related to this, children did not heed a simple “unwanted means undesirable” rule, holding that resources must be undesirable whenever supply exceeds demand. Against this possibility, children rated sandwiches as desirable in high demand conditions of the first two experiments, even though these conditions included leftover resources.

The findings are compatible, though, with multiple explanations of how children use supply and demand to infer desirability. One possibility is that children consider *scarcity*. Supply and demand both determine whether resources are scarce, and perceptions of scarcity could drive adults' valuations of objects (Brock, 1968; Cialdini, 1984, 1987; Worchel et al., 1975). It might seem unlikely that our participants made scarcity-based inferences, as recent studies find that young children do not value rare resources over common ones (Diesendruck et al., 2019; Echelbarger & Gelman, 2017; John et al., 2018). However, in these studies, children were provided with information about supply only, but no information about demand. So perhaps children can make scarcity-based inferences so long as they have information about *both* supply and demand to do so.

Another possibility is that children use supply and demand to infer desirability by drawing on the naïve utility calculus and their understanding of costs (Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016; Jara-Ettinger, Gweon, Tenenbaum, & Schulz, 2015; Liu, Ulman, Tenenbaum, & Spelke, 2017). Supply and demand are both relevant to the relative costliness of obtaining rewards, and this is true even if we ignore monetary costs. For example, the time spent waiting to buy a sandwich depends on the number of other customers (demand), and the wait is more likely to be successful if many sandwiches are available (supply). Hence, children might reason that resources must be desirable if they can see that people are willing to incur costs to obtain the resources, and even willing to risk failure (i.e., going home empty-handed).

Future research will be needed to test these accounts (and others). For example, to further explore the scarcity account, it would be helpful to examine whether children show signatures of adults' sensitivity to scarcity. And to test the naïve utility calculus account, it would be helpful to examine whether children recognize when obtaining resources will be costlier (e.g., in terms of

time or effort). Regardless, the fact that multiple accounts can be outlined raises the possibility that children employ a range of methods for making these inferences (see Koskuba, Gerstenberg, Lagnado, & Schlottmann, 2018 for evidence of pluralism in the ways children reward and penalize members of teams). Children may consider scarcity, willingness to incur costs, and other factors as well, as it appears that there are several reasons that supply and demand are informative about desirability.

To close, the present findings provide evidence that children consider both supply and demand when inferring resource desirability. These inferences may be valuable to children. They allow children to anticipate the non-obvious features of resources, while sparing children from having to incur the costs that would be required to obtain and directly sample the resources themselves.

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