Contextual Features Affect Children's Attention to Number

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Abstract

Prior research indicates that Spontaneous Focusing On Number (SFON) measured in the preschool years is predictive of mathematical achievement as late as age 12 (Hannula & Lehtinen, 2005; Hannula-Sormunen, Lepola, & Lehtinen, 2010). Therefore, there is great need to examine how young children's attention to number is affected by various contexts. This study investigated how heterogeneity vs. homogeneity of the arrays, and verbal labels for the quantities presented affected young children's attention to number, compared to their attention to cumulative surface area. We found that participants preference for and attention to number was correlated with their number knowledge, but only when the items they were presented with were homogeneous, not heterogeneous. This suggests that homogeneous arrays are important for children's attention to number and individuation and could be used as a tool to help children better hone in on mathematical concepts.

Introduction

In psychology today, there is significant research on the topic of Spontaneous Focusing On Number (SFON). SFON is a construct that represents individual's spontaneous, or self-initiated and unguided, focusing on abstract numerical aspects despite other attributes (Batchelor & Gilmore, 2015, Hannula & Lehtinen, 2005). Most researchers agree that children as early as 3 years old exhibit SFON and focus their attention to number without being primed (Hannula & Lehtinen, 2005), as humans are generally good at paying attention to number (Odic, 2017). This tendency of SFON is very important because research suggests that SFON measured in the preschool years is predictive of mathematical achievement as late as age 12 (Hannula & Lehtinen, 2005; Hannula-Sormunen, Lepola, & Lehtinen, 2010). We were interested in examining how the context of a task can affect number saliency specifically in SFON-type tasks. Therefore, in the current study, we aimed to address what factors influence the salience of number. We were specifically interested in the way individuating items (either visually or through verbal labels) can help children focus on number.

In addition to number, adults and children can pay attention to other quantity dimensions such as surface area, element size, or density for example (Lee, Baek & Chong, 2016). What makes some quantitative dimensions more salient than others has been a topic of interest in psychology for quite some time. Research with infants is mixed. In a habituation study, Clearfield and Mix (1999) presented infants with arrays of 2 or 3 squares that were constant in number and contour length. In test, infants were presented with displays that were either novel in number or novel in contour length, and they found that infants only dishabituated to the changes in spatial extent (either contour length alone or area alone) but not to the changes in number. Similarly, Feigenson, Carey and Spelke (2002), similarly found in a habituation paradigm that infants dishabituated to a change in surface area but not to a change in number when the two variables were pitted against each other. On the other hand, a study using a similar paradigm found evidence suggesting that infants can discriminate based on number alone (Cordes & Brannon, 2009). They attempted to replicate Clearfield and Mix (1999) and found that infants dishabituated to both novel number and novel contour length array, providing strong counter evidence to the claim that infants use only continuous extent and non-numerical cues when discriminating sets.

Additionally, some research has examined the relative salience of quantitative dimensions in children. Cantlon, Safford & Brannon (2010) use a delayed match-to-sample task with homogeneous squares, where one answer choice matched on cumulative surface area and one answer choice matched on number of squares. Children were told to simply “match” the sample stimuli and were given positive feedback regardless of answer choice. They showed that young children, 3-4 years old, spontaneously attend to number instead of cumulative surface area, demonstrating children’s sensitivity to number relative to other quantities. This suggests that by the age of 3-4-years-old, children are biased to attend to numerical properties over other quantitative dimensions.

In this study, we were interested in examining the effects of context on whether children pay attention to number compared to other quantity dimensions, specifically area. In fact, research suggests that children’s attention to number is strongly influenced by other features like shape and color (Chan & Mazzoco, 2017). They use a match-to-sample design, pitting number against shape and color (high salience) in half of the trials and pattern and orientation (low salience) in the other half and found that not only are their individual differences in children’s attention to number, but also that children’s attention to number is malleable and is more affected by contexts with high salience. Furthermore, there is research that suggests that the heterogeneity or homogeneity of an array of shapes (specifically in terms of color and shape) can also play an important role in whether or not people pay attention to number. Research with older children and adults shows that heterogeneous arrays are beneficial to counting and individuating (Frick, 1987). While research on children suggests they prefer homogeneity; some research has suggested that children find it more difficult to match based on number when arrays are heterogeneous (Mix, 1999; Cantlon, Fink, Safford, & Brannon, 2007). Cantlon, Fink, Safford, & Brannon used a match-to-sample task to examine the effects of heterogeneity on 3-5-year-old children and varied the stimuli by size, color, and shape and found that heterogeneity impaired performance. Other research suggests that individuating each item, such as by counting, helps children match on number, but that children are more accurate at enumerating arrays when they are homogeneous over heterogeneous ones (Posid & Cordes, 2015). Using a card game matching task where participants were instructed to find the number 6 that corresponded to 6 animals on a card, while the other choice option ranged from 4-18 animals on a card. Posid and Cordes found that children 3-6-years-old, had an overall performance bias for homogeneous trials. However, when children spontaneously counted, it improved their attention to number, assisting in individuation and eliminated the homogeneity bias.

Another contextual feature we were interested in is how verbal labels affect children's propensity to pay attention to number. While research with infants shows that verbal labels can help them categorize concrete objects (e.g. animals, Ferry, Hespos & Waxman, 2010; Waxman & Braun, 2005), research that has examined the effects of verbal labels on abstract categories like number is less clear. Cantrell and Smith (2013) find verbal noun labels help children focus on individual shapes. In a match-to-sample task comparing set size, numerosity, and shape, Cantrell and Smith found that when 3-5-year-old children were presented with verbal noun labels during sample stimuli, they were better at matching by shape and that there where interactions between set size and language, suggesting that verbal label help focus children's attention on the individual shapes. Additionally, research shows us that the categorization process is important for numerical development (Mix, Huttenlocher, & Levine, 1996) and that children with strong label knowledge are more likely to recognize numerical equivalence (Mix, 2008).

Research on verbal labels impacting attention to number is often examined in the context of number words. Children at preschool age are learning words for numbers and often the "number talk" they hear can influence their later understanding of number (Levine et al., 2010). One common task to measure children's number knowledge and counting, that also hones in on children's number language, is the Give-N Task (Wynn, 1992). In Give-N children have a set of items and are asked to produce subsets (*N*) of those items. The Give-N Task is both a test of number knowledge, as well as number language acquisition. If the child cannot get any number correct in this task, this means they are unable to understand that each number word holds a specific numerosity. This task demonstrates just how important verbal labels are for children's development of number knowledge.

The current work strives to add to our knowledge of the learning processes of number knowledge in young children and learn more about what features can best guide children's attention to number as opposed to other quantity dimensions. Specifically, we investigated children's attention to number when pitted against cumulative surface area. Furthermore, we manipulated how heterogeneity vs. homogeneity of the arrays and verbal labels for the quantities presented may have an effect on SFON. The literature shows that heterogeneity affects attention to number and that surface area affects attention to number, but there is still a missing connection when these two factors are combined; how does heterogeneity affect attention to number when it is pitted against surface area. The first research question this study posed was: does heterogeneity help children focus on number? To explore this question, we designed a match-to-sample task where children were tasked with picking which picture best matched the sample picture, however importantly one of the choice pictures matched the sample on number, while the other match on cumulative surface area. Importantly, we varied whether the arrays presented were heterogeneous, in shape and color within the sets, or homogeneous, in shape and color within the set but the configuration of the shapes differed. Here we hypothesized that homogeneity would help children pay attention to cumulative area and result in less individuation. The second research question this study sought to answer was: do verbal labels help children focus on number? To explore this question, we presented a match-to-sample task identical to the first task (but with only homogeneous arrays), where half of the participants were presented with a verbal noun label while viewing the sample picture and the other half were not. Here we were interested in examining whether the label they heard would promote the likelihood that the child made a numerical match. We hypothesize that verbal noun labels would assist children in focusing on numeric matches over area matches.

Method

Participants

Participants were 61 4-6.5-year olds (mean age = 4.99 years, range: 3.96 years – 6.46 years). Five participants were excluded because they did not complete at least one of the three tasks. Thirty-five of the children were female. Children were recruited from the Boston area, through local preschools, in the Infant and Child Cognition Lab of Boston College, as well as through the Living Laboratory program at the Boston Museum of Science and at the Boston

Children's Museum. Informed consent was obtained from the parent or legal guardian of each child before participation in the experiment.

Task and Procedure

Children completed 3 tasks always in the following order: a Heterogeneous and Homogeneous Matching Task, a Verbal Label Matching Task and a Give-N Task.

Heterogeneous and Homogeneous Matching Task. This match-to-sample task, modeled after Chan and Mazzocco (2017), was presented on a 13-inch Macbook pro laptop. The aim of this task was to measure which of two dimensions (number or cumulative surface area) children would use spontaneously in a matching game. Importantly, some of the trials presented children with heterogeneous arrays of shapes, while other trials were homogeneous; we were specifically interested in measuring which of these two trial types would facilitate number matching. In this delayed match-to-sample game, the child was told they would "be playing a matching game". On each trial, children were presented with a sample stimulus that children were asked to remember. Once the child was done remembering the picture the experimenter then pressed the space bar key to proceed. Next, they saw three choice stimuli and the participants were instructed to point to the "best match." The experimenter then pressed the number keys 1, 2, or 3, depending on if the child selected the left, middle, or right stimulus, respectively.

Importantly, there were three types of trials: Practice, Standard, and Probe trials. Practice and Standard trials were identical in that they had one correct answer that matched the sample stimulus on both number and cumulative surface area, and two incorrect answers that did not match on either number nor surface are. In Probe trials, we pitted number against surface area. One choice picture matched the sample stimulus on the number of shapes, one choice picture matched the sample on the total cumulative area of the shapes, and one choice picture was a foil and did not match on either of these characteristics. On Standard and Practice trials, the child was given positive visual and auditory feedback for selecting the stimulus that matched on both the number and cumulative area of shapes (a smiley face with auditory sound track of cheering kids) and negative feedback for choosing either of the other two choices (an 'x'). Additionally, the experimenter would reinforce the feedback. On Probe trials, the child received positive feedback for selecting either the number match or surface area match (Figure 1).

Children completed a total of 28 trials: 4 Practice trials (2 homogeneous and 2 heterogeneous), 12 Standard trials (6 homogeneous and 6 heterogeneous) and 12 Probe trials (6 homogeneous and 6 heterogeneous). To familiarize participants with the task, they were first shown the 4 Practice trials; these trials were identical in design to Standard trials but were used to acclimate children to the task. Following the Practice trials, children were then tested with randomized mix of Standard and Probe trials. Trials were randomized across participants and included both heterogeneous and homogeneous arrays within participants (Figure 1). Children saw an attractor video (22 secs) every 9 trials.

Stimuli. Stimuli were created with Adobe Illustrator Software (Version CS5). Each stimulus was presented on a background of 10.5 cm x 13.2 cm. Sample stimuli of two-, three-, or four- unfamiliar geometric shapes in random arrays were displayed in the center of the laptop screen. Then three choice stimuli where displayed in equal thirds on the laptop screen. The spatial configuration of the elements was randomized across each stimulus. Stimuli were designed as nonsense shapes to ensure that participants could not use geometric shape knowledge as a cue to match sample to choice stimuli. Shapes, colors, and the distributions of stimuli onto the background were random. The cumulative areas of the sample stimuli ranged from 2.44 cm^2 - 3.67 cm^2 and increased in increments of 1.58 cm^2. Element areas ranged from 1.22 cm^2 - 2.77 cm^2. We did not want the shapes to appear too densely packed, nor did we want them difficult to see. Therefore, we designed the stimuli so that in our smallest number of shapes, only 2 shapes, with the smallest cumulative area, 2.44 cm^2, the shapes would appear appropriately sized on a background of 10.5 cm x 13.2 cm and so that our largest number of shapes, 4 shapes, with the largest cumulative area, 3.67 cm^2, would also look appropriately sized. Additionally, we sized our stimuli to ensure we had noticeable differences between each cumulative area sample size.

Stimuli comparisons consisted of small sets, 2v3, 2v4, and 3v4. Small sets were chosen because research in progress in the Infant and Child Cognition Lab is finding that young children find it very hard to use number cues to match in match-to-sample tasks with large sets so we wanted to provide participants with the ability to match based on number if they spontaneously wanted to. Additionally, in Standard and Practice trials we designed our stimuli so that the number of shapes in the 'incorrect choices' are selected from the *other* small set comparisons we used. For instance, when we had a Sample stimulus of 3 shapes, our incorrect choices would have 2 and 4 shapes (Example 1; Fig. 1). In Probe trials, we followed this same method and selected the number of shapes in the foil choice from the additional comparison number. Therefore, for a 3v4 comparison, our sample stimulus would have 4 shapes, our number match would also have 4 shapes, our area match would have 3 shapes and our foil would have 2 (Example 3; Fig. 1).

Verbal Label Matching Task. The design of this task was identical to the Het and Hom Matching Task except for the following. Participants were only presented with homogeneous Probe trials while also listening to a labeling phrase when both the sample and choice stimuli appeared. Participants were randomly assigned to either the Label or No Label condition. At the start of the task, the child was told they would be playing another matching game that was similar to the previous one, but this time they were asked, "to look with your eyes and listen with your ears." If the testing area was deemed too noisy (when testing outside of the lab), then over-the-ear headphones were placed on the child to ensure that no outside noise would distract the child. Similar to the previous task, children were presented with a sample picture containing an array of shapes, but this time children were also presented with a verbal label. Participants in the Label conditions heard "look at the ___". The word used to fill in the bank was a one syllable, three letters, nonsense noun: *bif, wam, tus, ziv, ket, pel, dak, kug, bem, joj, fos, vob*. Conversely, children in the No Label condition heard an audio clip say, "find the picture here". The experimenter then pressed the space bar key to proceed to the choice stimuli screen. Here children in the Label condition heard the phrase "find the ___ here", with the blank being the same nonsense noun they heard in the sample. Children in the No Label condition heard "find the matching picture here." The experimenter then pressed the number keys 1, 2, or 3, depending if the child selected the left, middle, or right stimuli picture, respectively. Since children were only presented with Probe trials here, they received positive visual and auditory feedback when selecting either the number or surface area choice. And negative feedback for selecting the foil choice. Verbal instructions were modeled after Cantrell, Lisa, and Smith (2013) and trials were randomized across participants.

Stimuli. Although stimuli in the Verbal Label Matching Task were novel, stimuli creation was identical to how Probe stimuli of the Heterogeneous and Homogeneous Matching Task.

Give-N Task. The Give-N Task is a measure of numerical understanding in children (Wynn, 1992). In the Give-N Task, children are asked to put a certain number of toys (N) in a basket. Every time the child correctly puts N toys into the basket, the experimenter increases the number of toys asked for by N+1, but whenever the child makes a mistake, the experimenter asks for N-1 toys, following a titration method. The task continues until the child has two successes for a given number of toys, N, and two failures for N+1. N represents the child's maximum number concept knowledge.

In our version of this task, children were presented with 20 possible small rubber ducks and a small plastic basket. The experimenter first demonstrated the game by putting one duck into the basket. The child was then asked to put one duck into the basket, and once done, was asked a verification question, "is that one duck?" If the child responded that it was not, they were given a chance to fix the mistake, otherwise the experimenter moved onto the next trial. Each time the child succeeded, the experimenter asked the child to put in one more duck (N+1), otherwise the request was decreased to N-1. The numbers two and eight were skipped if the child succeeded on one and seven to reduce the number of trials children had to perform. The task continued until the child successfully put 10 ducks into the basket twice, or had two successes for a given number, N, and two failures for N+1. A child's number knowledge was determined by N. It is accepted that the Give-N Task demonstrates a child's number knowledge at that particular point in time. Children who have a number knowledge less than 6 are considered subset knowers, while children who score 6 and above are referred to as "cardinal-principle knowers" (CP knowers) since at this point they have mastered the cardinality principle.

Results

Task: Het and Hom Matching Task

In the Heterogeneous and Homogeneous Matching Task, we found that participants performed significantly above chance (chance is 33%) on Standard trials (62%; $t(60)=10.66$, $p<.001$). Similarly, the proportion choosing number on Probe trials was also significantly above chance (62%; $t(59)=10.15$, $p<.001$). On the other hand, the proportion a participant selected the area choice on Probe trials was significantly below chance (21%; $t(59)=-7.45$, $p<.001$). This means not only that participants understood the task (performance on Standard trials), they are also showing a preference for number, to the extent that they are actively avoiding picking the area choice in Probe trials (Fig. 2).

Next, we compared performance on the heterogeneous trials and homogeneous trials through paired sample t-tests. On Standard trials we found that participants performed significantly better on homogeneous trials (67% correct) compared to the heterogeneous trials (55% correct), $t(59)= -3.46$, $p<.001$ (Fig 3.). However, we found no such difference for the proportion picking either the number or the area match on Probe trials. Participants selected the number choice about 61% on heterogeneous trials and 64% of the time on homogeneous trials, $t(59)= -.69$, $p=.435$. Similarly, participants selected the area choice 19% on the time for heterogeneous trials and 23% of the time for homogeneous trials, $t(59)= 1.83$, $p<.172$ (Fig. 3).

Task 2: Verbal Label Matching Task

In the Verbal Label Matching Task, we found that the proportion of participants choosing number on Probe trials was also significantly about chance across both conditions (57%; $t(59)=7.71$, $p<.001$). On the other hand, the proportion a participant selected the area choice on Probe trials across both conditions was significantly below chance (24%; $t(59)=-4.67$, $p<.001$).

This again demonstrates that participants showed a preference for number, to the extent that they are actively avoiding picking the area choice in Probe trials (Fig. 4).

Next, we analyzed whether the verbal label had a significant effect on performance using an independent samples t-test. We found no significant difference between the Label condition when participants selected number (M=0.54, SD=0.26) and No Label condition when participants selected number (M=0.63, SD=0.25); $t(45)=1.19$, $p=.83$. Nor did we find any significant difference between the Label condition when participants selected area (M=0.25, SD=0.17) and No Label condition when participants selected area (M=0.22, SD=0.13); t(45)=-.79, $p=.20$ (Fig. 5). This finding illustrates that labeling sets with a verbal nonsense word does not help children focus on area nor number better.

We then calculated a difference score between the proportion participants selected number and the proportion participants selected area. Although there was a greater difference in the No Label condition (39%) than in the Label condition (28%), it was not significant, $t(58)=1.14$, $p=.68$.

Relationship with Give-N

The average knower level on our Give-N Task was 8.73, ranging from 2-10. We had 9 subset knowers (with a number knowledge of 5 and below), and 47 cardinal principle (CP) knowers (with a number knowledge of 6 and above; Fig. 6).

We then ran correlations among all types of trials in Task 1, Het and Hom Matching Task (Table 2). We found that the total proportion correct on Standard trials correlated with Give-N, ($r=.46$, $p<.001$). This showed that participants who have a higher number knowledge were generally better at the task. We also found that performance on homogeneous Standard trials was positively correlated with Give-N, $r=.48$, $p<.001$, while performance on heterogeneous Standard trials was only marginally correlated with Give-N, r=.29, p<.05, meaning that participants with a higher number knowledge were better at selecting the correct answer in homogeneous Standard trials but only marginally better in heterogeneous Standard trials (Fig. 7).

Similarly, we found significantly positive correlations with Give-N on proportion picking number on Probe trials, r=.50, p<.00. When breaking this down by trial type, we found Give-N and choosing number on homogeneous Probe trials was positively correlated, r=.58, p<.001, although this was only marginally correlated for heterogeneous trials, r=.27, p=0.05 (Fig. 8).

On the other hand, we found no significant correlations overall, r=-.22, p=0.10, nor a significant correlation on heterogeneous trials, r=-.004, p=0.98, between Give-N performance and the proportion of trials in which the child selected the area match. However, we did find a significant and negative correlation on homogeneous trials when participants selected area, r=-.32, p<0.05 (Fig. 9). This illustrated that the children with higher number knowledge are less likely to pick the area match in homogeneous Probe trials. So not only are they picking number in homogeneous Probe trials, but they are also actively avoiding the area choice as their knower level goes up.[1]

Similar to Task 1, we ran correlations for all trials in Task 2 and Give-N (Table 3). We found that Give-N correlated positively with trials where participants selected number, r=0.32, p<0.05, and marginally negatively correlated with trials where participants selected area, r=-.26, p<0.05. This again shows, that regardless of the verbal label, children with better number knowledge, are more likely to choose number and less likely to choose area. Additionally,

[1]We also ran partial corrections and controlled for age and found all the patterns to be consistent. Furthermore, when we excluded all subset knowers, the same pattern of findings held.

number and area are negatively correlated, r=-.86, p<0.001, which demonstrates that children who are picking number, are also actively avoiding picking area, regardless of condition.

Discussion

In this study, we examined how the context of a task can affect number saliency in SFON type tasks. We aimed to address how heterogeneity vs. homogeneity of the arrays, and verbal labels for the quantities presented may affect children's focus on number when pitted against cumulative surface area. The first research question this study posed was: does heterogeneity help children focus on number? We found that there was a significant and meaning difference between heterogeneity and homogeneity for young children when attending to number. In particular, for homogeneous trials, we found that the proportion choosing number was positively correlated with number knowledge, while this was not the case for heterogeneous trials. Additionally, we found only for homogenous trials, there was a significant negative correlation between the proportion choosing area and number knowledge. This suggests that while children with higher number knowledge, or better individuating skills, are more likely to pick number and also are actively avoiding picking area, this is only the case when the arrays children are presented with are homogenous in color and shape. While we had hypothesized that homogeneity would help children pay attention to cumulative area and result in less individuation, we found that overall, children paid significantly more attention to number, regardless of hetero- or homo-geneity. Conversely, children were able to attend more to number when trials were homogeneous. One possible explanation for this finding could be that homogeneous arrays are less distracting for children and therefore provides them more cognitive opportunity to attend to number.

The second research question this study sought to answer was: do verbal labels help children focus on number? We found that this was not the case, so regardless of whether children heard a verbal label, they were not more or less likely to pay attention to number. This illustrated that labeling sets with a verbal nonsense word is not helping children focus on area nor number better. We had hypothesized that verbal noun labels would assist children in focusing on numeric matches over area matches but found that verbal labels did not assist children at all. One possible explanation for this finding could be that the design of our study did not truly hone in on verbal label ability, as all participants heard an audio recording, regardless of condition, and the difference between the stimuli was not distinctive enough.

Some limitations with this study is the still relatively small sample size. Although the sample size is sufficient to provide valuable analysis, at this point we cannot make any conclusive statements about our findings. A future study direction that is presently underway in the Infant and Child Cognition Lab is an adult version of this study to see if heterogeneity and homogeneity affects adult's attention to number vs. surface area. Research suggests that in adults, heterogeneity better facilitates number attention (Frick, 1987); we are finding the opposite for children so this became something we were interested in studying. We therefore designed a study that was very similar to the present study. It is still a match-to-sample task with nonsense shapes except it is not self-paced and adults only see the sample stimuli for 750 milliseconds because we want to get at spontaneous attention, and what they are intuitively focusing on. Additionally, because small sets of 2, 3 and 4, would be too easy for adults, we are examining large set comparisons of between 8 and 23 (8v13, 8v18, 8v23, 13v23, 18v23) At this time we have 22 participants, average age is 28.2 years, 12 female and 10 male. Participants have been recruited from Museum of Science Living Laboratory. No analysis have been run nor examined at this point but we are looking forward to future data.

In conclusion, we found that participants preference for and attention to number was correlated with their number knowledge in homogeneous arrays only. Our results extend previous findings that young children have a homogeneity bias when making numerical judgments. This finding is important as research suggests that children's attention to number is predictive of later arithmetic and math achievement (Hannula & Lehtinen, 2005; Hannula-Sormunen, Lepola, & Lehtinen, 2010), therefore honing in on how to best help children attend to number could be an invaluable teaching tool. However, further research would benefit from investigating ways to help children attend to number in heterogeneous arrays, to imitate more real-world settings, as the world is rarely perceptually homogeneous.

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Appendix – Tables, Graphs, Figures

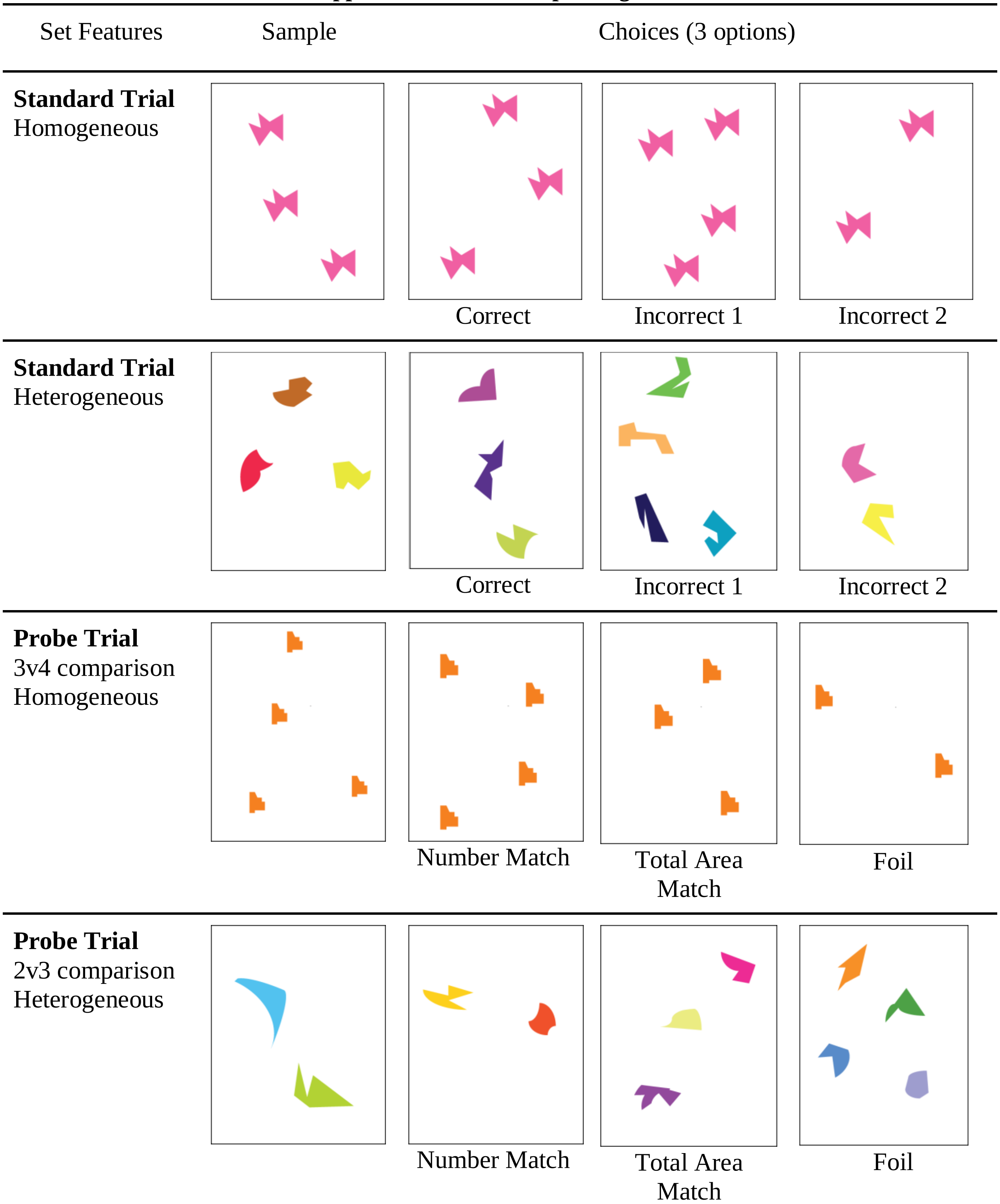

Fig. 1. Exemplars of each of the four stimulus combinations used in Task 1. Each combination included one sample and three response choices. Although features appear in the same relative location in this figure, with correct / number match answers always appearing first, in the actual task the location of the features/foils was randomized between participants.

Table 1
Descriptive Statistics

	N	Average	Minimum	Maximum	Std. Deviation
Prop Correct Practice: Task 1	61	0.70	0.00	1.00	0.26
Prop Correct Standard: Task 1	61	0.62	0.08	1.00	0.21
Total Prop Area: Task 1	60	0.21	0.00	0.50	0.13
Total Prop Number: Task 1	60	0.62	0.17	1.00	0.22
Prop Area Het Probe: Task 1	60	0.23	0.00	0.67	0.18
Prop Number Het Probe: Task 1	60	0.61	0.17	1.00	0.25
Prop Area Hom Probe: Task 1	60	0.18	0.00	0.67	0.18
Prop Number Hom Probe: Task 1	60	0.63	0.17	1.00	0.27
Prop Number: Task 2	60	0.57	0.00	1.00	0.24
Prop Area: Task 2	60	0.24	0.00	0.58	0.151
Age	61	5.01	3.96	6.62	0.69
Give-N	56	8.55	2	10	Subset: 9 CP: 47

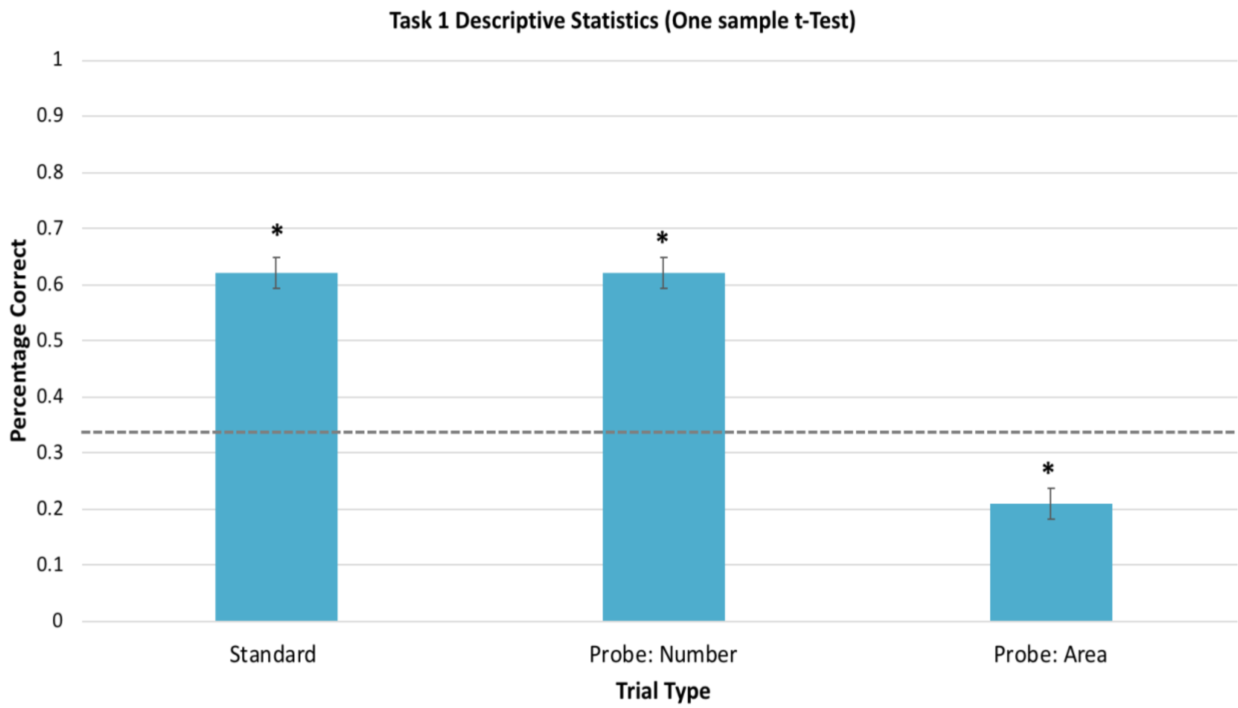

Fig. 2. Task 1 Descriptive Statistics

Notes.
*. *p*<.01

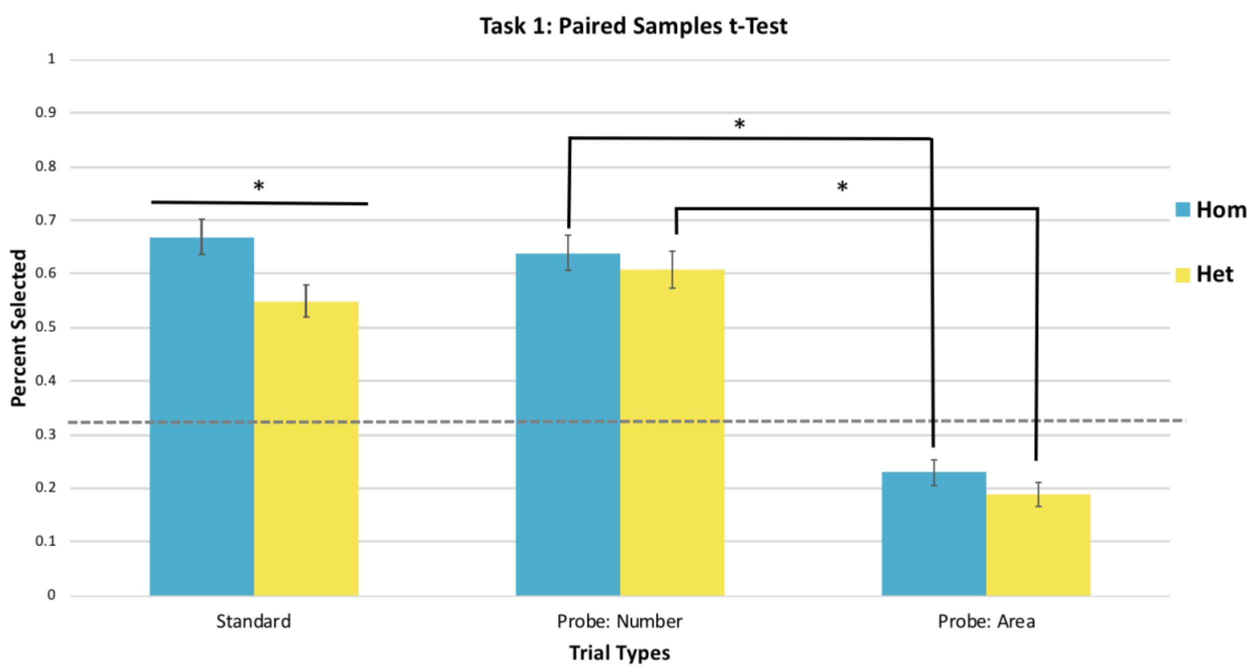

Fig. 3. Task 1 Effects Between Trials

Notes.
*. *p*<.01

Fig. 4. Task 2 Descriptive Statistics

Notes.
*. *p*<.01

Fig. 5. Task 2 Relationship Between Conditions

Notes.
*. *p*<.01

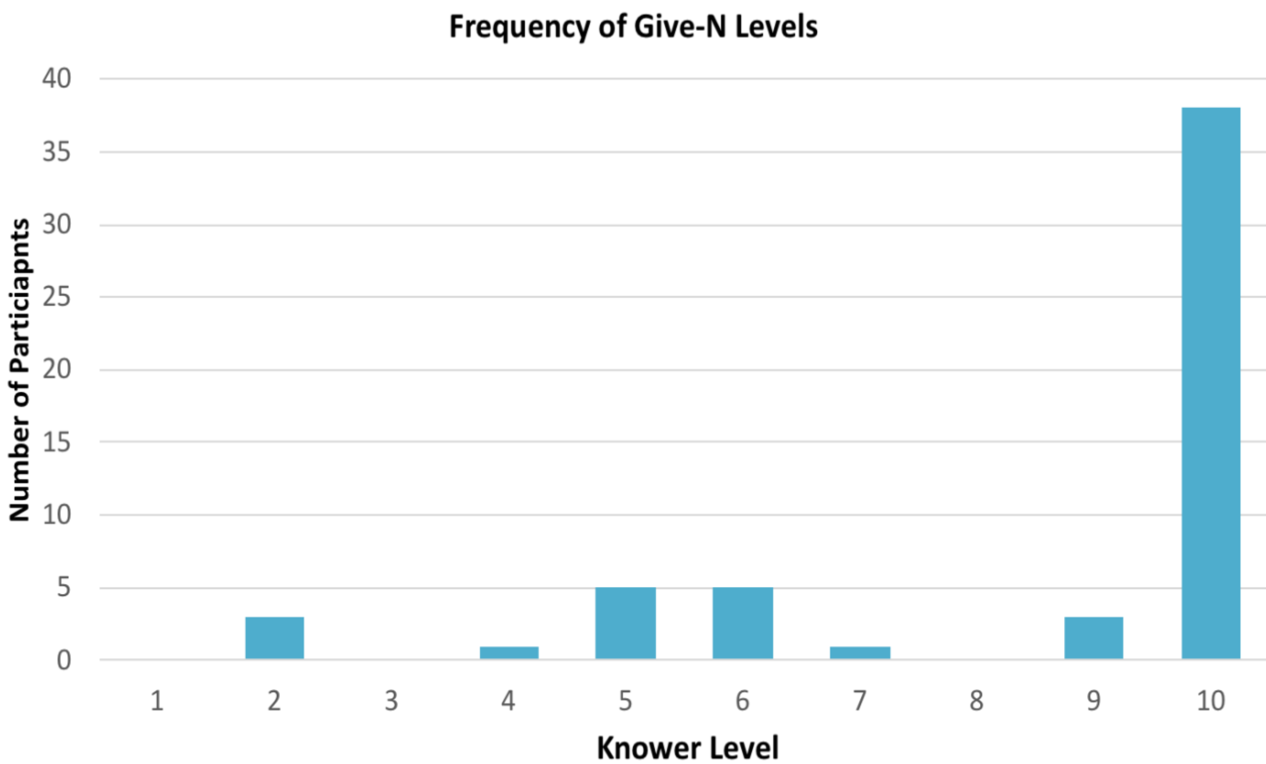

Fig. 6. Give-N Level Frequency

Fig. 7. Task 1 Correlations with Give-N and Standard Trials

Notes.
*. *p*<.05
***p*<.01

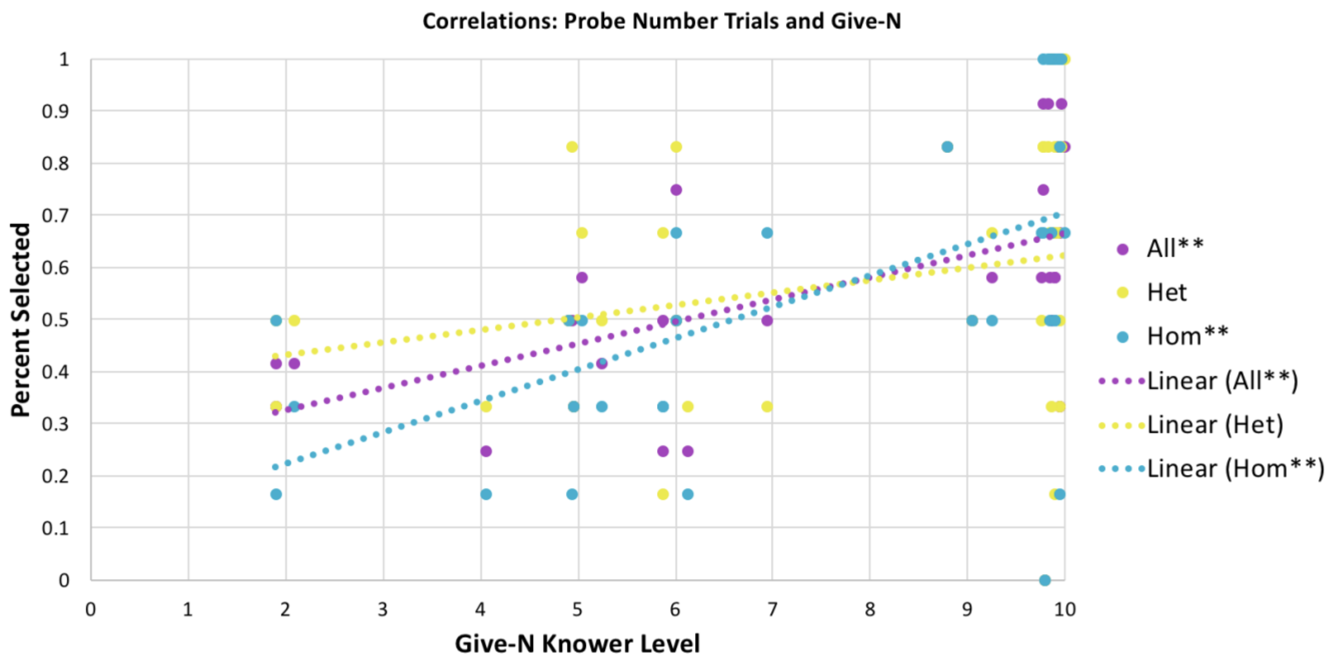

Fig. 8. Task 1 Correlations with Give-N and Probe Number Trials

Notes.
*. *p*<.05
***p*<.01

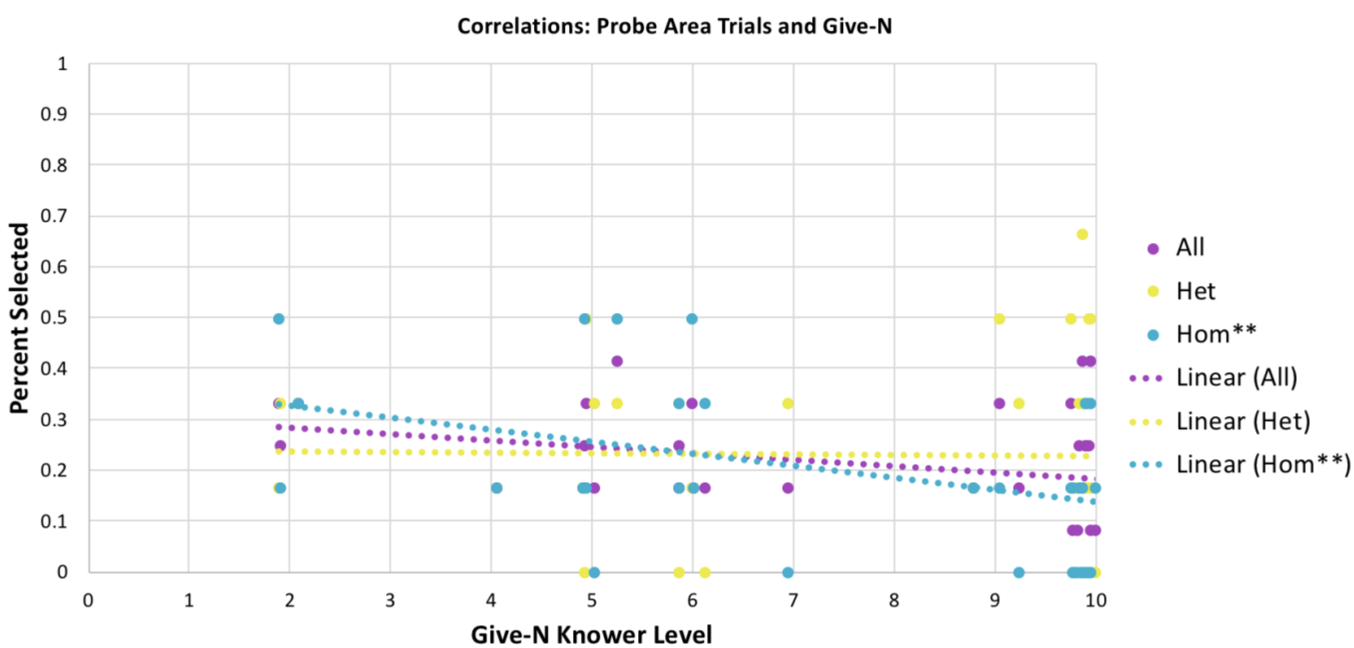

Fig. 9. Task 1 Correlations with Give-N and Probe Area Trials

Notes.
*. *p*<.05
***p*<.01

Table 2
Correlations on Task 1

	2	3	4	5	6	7	8	9	10	11
1. Age	.27* (*N*=61)	-.15 (*N*=60)	.30* (*N*=60)	.27* (*N*=60)	-.16 (*N*=60)	.27* (*N*=60)	.22 (*N*=61)	-.05 (*N*=60)	.24 (*N*=60)	.38** (*N*=56)
2. Proportion Correct on All Standard		-.66** (*N*=60)	.80** (*N*=60)	.85* (*N*=60)	-.48** (*N*=60)	.60** (*N*=60)	.82** (*N*=61)	-.50** (*N*=60)	.75** (*N*=60)	.46** (*N*=56)
3. Proportion Chose Area on All Trials			-.76** (*N*=60)	-.58** (*N*=60)	.74** (*N*=60)	-.64** (*N*=60)	-.51** (*N*=60)	.73** (*N*=60)	-.66** (*N*=60)	-.22 (*N*=55)
4. Proportion Chose Number on All Trials				.67** (*N*=60)	-.55** (*N*=60)	.84** (*N*=60)	.65** (*N*=60)	-.57** (*N*=60)	.87** (*N*=60)	.50** (*N*=55)
5. Proportion Correct on Het Standard					-.53** (*N*=60)	.58** (*N*=60)	.37* (*N*=60)	-.32** (*N*=60)	.57** (*N*=60)	.29* (*N*=55)
6. Proportion Chose Area on Het Probe						-.70** (*N*=60)	-.24 (*N*=60)	.08 (*N*=60)	-.26* (*N*=60)	-.004 (*N*=55)
7. Proportion Chose Number on Het Probe							.41** (*N*=60)	-.24 (*N*=60)	.46** (*N*=60)	.27 (*N*=55)
8. Proportion Correct on Hom Standard								-.51** (*N*=60)	.67** (*N*=60)	.48** (*N*=56)
9. Proportion Chose Area on Hom Probe									-.71** (*N*=60)	-.32** (*N*=55)
10. Proportion Chose Number on Hom Probe										.57** (*N*=55)
11. Give-N										

Notes.
*. *p*<.05
***p*<.01

Table 3
Correlations on Task 2

	2	3	4
1. Age	.38** (*N*=56)	.36** (*N*=60)	-.21 (*N*=60)
2. Give-N		.32** (*N*=56)	-.26* (*N*=56)
3. Proportion Chose Number			-.86** (*N*=60)
4. Proportion Chose Area			

Notes.
*. p<.05
**p<.01