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# Word meaning is complex: Language-related generalization differences in autistic adults

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ABSTRACT

The current study marries two important observations. First, there is a growing recognition that word meanings need to be flexibly extended in new ways as new contexts arise. Second, as evidenced primarily within the perceptual domain, autistic individuals tend to find generalization more challenging while showing stronger veridical memory in comparison to their neurotypical peers. Here we report that a group of 80 autistic adults finds it more challenging to flexibly extend the meanings of familiar words in new ways than a group of 80 neurotypical peers, while the autistic individuals outperform the neurotypicals on a novel word-learning task that does not require flexible extension. Results indicate that recognized differences in generalization present an ongoing challenge for autistic adults in the domain of language, separate from social cognition, executive function, or the ability to assign single fixed meanings to new words.

> *"the word* jumping *triggers a memory of jumping hurdles at the Mock Olympics held at my elementary school….* 'he ran quickly' *triggers an animated image of Dick from a first-grade reading book"* (Grandin, 2006).

## 1. Introduction

People typically underestimate the complexity of word meanings and the flexibility required to use words appropriately, as people often assume each word refers to a clear-cut, fixed category (Gelman, 2003). Yet the most common words apply to highly complex categories of meanings (Lakoff, 1987; Murphy, 2002; Wittgenstein, 1953). For instance, the English word *cap* can refer to a bottle cap, pen cap, or mushroom cap; *sorry* can express a genuine apology, a polite means of excusing oneself, or an expression of sympathy. Word meanings are routinely extended as new situations arise (Christiansen & Chater, 2022; Elman, 2009; Mikolov, Chen, Corrado, & Dean, 2013). Both children and adults regularly select terms that are "good enough" to serve their intended purpose; for instance, a speaker may call a pencil a *pen* if the word *pencil* is temporarily inaccessible at the moment of speaking (Casasanto, 2015; Clark, 2023; Goldberg, 2019; Goldberg & Ferreira, 2022; Koranda, Zettersten, & MacDonald, 2022). Given the need to use familiar words flexibly, we can predict that difficulties flexibly extending meanings will complicate communication.

This prompts our investigation into language and autism since autistic individuals tend to display greater attention to detail and a reduced tendency to generalize in comparison to individuals not diagnosed with autism (hereafter, neurotypicals or NTs). In particular, autistic individuals tend to display more veridical memory of instances, an observation primarily documented in perceptual tasks (Goldstein, Johnson, & Minshew, 2001; Iarocci & McDonald, 2006; Kaplan-Kahn, Park, & Russo, 2021; Klinger & Dawson, 2001; Kopec et al., 2020; Mottron & Burack, 2001; Mottron, Burack, Iarocci, Belleville, & Enns, 2003; Mottron, Dawson, Soulieres, Hubert, & Burack, 2006; Peck et al., 2021; Plaisted, 2000; Plaisted, 2001, although see Simmons & Todorova, 2018). For instance, autistic individuals are more likely to recognize visual entities that are highly similar as distinct (Soulières, Mottron, Saumier, & Larochelle, 2007), and tend to outperform NTs in discriminating phonetic distinctions as well (Eigsti & Fein, 2013; Remington & Fairnie, 2017).

Perception that is more veridical can be beneficial but may incur a cost when generalizing across instances is helpful, insofar as more detailed perceptions tend to be accompanied by a tendency to overlook

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similarities and relatedness (Happé & Booth, 2008; Happé & Frith, 2006; Mottron et al., 2013). For example, autistic individuals tend to be less accurate than NTs when asked to identify which of two dot patterns is more similar to a target pattern (Plaisted, O'Riordan, & Baron-Cohen, 1998). When asked to compare two tones, NTs are influenced by an emergent category of tones witnessed across previous trials: the first of two tones being compared on a trial is treated by neurotypicals as if it were closer to the statistical average than it actually was; on the other hand, autistic individuals do not show evidence of forming the statistical average (Braida et al., 1984; Eigsti & Fein, 2013; Jaffe-Dax & Eigsti, 2020; Lieder et al., 2019). More generally, autistic individuals display a reduced tendency to form complex categories (Church et al., 2010; see Vanpaemel & Bayer, 2021 for review). Intriguingly, autistic children's receptive vocabulary has been found to correlate with their tendency to generalize in such non-linguistic tasks (Eigsti & Fein, 2013).

There is also evidence for reduced generalization outside the perceptual domain. In comparison with NTs, autistic adults are less prone to false memories that arise from generalizing beyond actual experience (Beversdorf et al., 2000; Hillier et al., 2007; Wojcik et al., 2018). Being able to generalize learned skills in appropriate new contexts is important for the skills to be used in daily life (Gunning et al., 2019), yet autistic individuals struggle to generalize successful strategies more than their NT peers do (de Marchena, Eigsti, Worek, Ono, & Snedeker, 2011; de Marchena, Eigsti, & Yerys, 2015). Autistic children are also less likely to generalize a property from one member of a category to other instances of the category than their NT peers; for example, when shown an image and told "This black cat can see in the dark" and then shown a picture of another black cat in a different pose and asked, "Can this black cat also see in the dark?" autistic children are less likely to say "yes" than NT children are (Naigles, Kelley, Troyb, & Fein, 2013; Tecoulesco, Fein, & Naigles, 2021).

Yet the majority of work aimed at identifying communication challenges in autistic populations has overlooked a potential role for generalization differences. Instead, research has tended to focus on differences in social cognition (Anderson et al., 2007; Baron-Cohen, 1993; Carpenter & Tomasello, 2000; Ellis Weismer & Kover, 2015; Kuhl, Coffey-Corina, Padden, & Dawson, 2005; Osterling & Dawson, 1994; Mundy, Sigman, and Kasari, 1990; Paul, Campbell, Gilbert, & Tsiouri, 2013; Sigman & McGovern, 2005; Tenenbaum, Sobel, Sheinkopf, Malle, & Morgan, 2015) or differences in executive function (e.g., Ellis Weismer, Kaushanskaya, Larson, Mathée, & Bolt, 2018; Friedman & Sterling, 2019; Hill, 2004). Notable exceptions include the observation that autistic children are less likely than NT children to generalize word labels of concrete objects by generalizing their shape (Potrzeba, Fein, & Naigles, 2015; Tek, Jaffery, Fein, & Naigles, 2008; Tovar, Rodríguez-Granados, & Arias-Trejo, 2020). Other relevant work has found that autistic children, aged 7–14, were as challenged by learning novel words assigned multiple *related* novel meanings (*polysemes*) as they were by learning novel words assigned multiple *un*related novel meanings (*homonyms*); NT children, on the other hand, display a marked advantage for learning polysemes over homonyms, seeming to spontaneously form a complex category of related meanings (Floyd & Goldberg, 2021; Floyd, Jeppsen, & Goldberg, 2021).

The current work extends these prior findings in important ways. First, the prior work on polysemes relied on novel labels for novel objects. In order to determine whether autistic individuals find it challenging to extend the meanings of real words in realistic ways, the current study tests the ability of a large group of autistic individuals to extend familiar words to semantically related, familiar entities. Moreover, the current meaning extensions rely on a variety of relationships including related functions, rather than exclusively focusing on shape or other perceptual features. In addition, prior work in this domain has focused almost exclusively on children. Since delays in language development are very common among autistic individuals, it remains unclear whether verbal adults ultimately achieve parity with NTs. Therefore, the current experiment tests adults. Finally, the current work employs a second task, which differs primarily in the need for flexible extension; this allows us to compare autistic and neurotypical groups on the variable of interest as directly as possible.

The current preregistered study assesses how easily autistic adults assign familiar words to plausible new meanings in comparison to their NT peers. Specifically, after demonstrating familiarity with the conventional meanings of each target word, participants took part in a *Flexible Meaning Extension* (FME) task, where they were asked to select the most plausible extended meaning in a four-alternative forced choice (4AFC) task (Fig. 1).

The target meaning extensions were inspired by co-lexification patterns in languages other than English (e.g., the same word, *tapa*, is used to label both lids and caps in Spanish; Rzymski et al., 2020; see also Floyd, Goldberg, & Lew-Williams, 2020). Fourteen pairs of common words and novel meaning extension images were selected based on preregistered norming criteria to ensure that each target word was a plausible, but not commonly used label for the extension image. The norming additionally collected judgments about how similar in shape each target image was to the conventional meaning of each word. See SI·D for specifics about the norming and inclusion criteria.

Since brief online measures of executive function can be unreliable (Camerota, Willoughby, & Blair, 2020), in order to provide a way to assess focused attention, motivation, and skill in learning one-to-one mappings between labels and images, a Label Learning (LL) task tested participants' ability to learn eight one-to-one mappings between new words and novel objects. Like the FME task, LL was a 4AFC task: participants were required to choose which novel object matched the label that had been provided during exposure. Unlike the FME task, the LL task required no generalization.

We hypothesized that generalization challenges would impact even verbal autistic adults. Specifically, we predicted that in comparison to neurotypicals, autistic adults would find the FME task particularly challenging compared to the LL task. That is, we predicted an interaction between group and task, which would suggest that the difficulty autistic individuals face in generalization impacts their ability to interpret word meanings flexibly, while other aspects of word learning would be more comparable between the two groups.

## 2. Methods

Design, sample sizes, exclusion criteria, and analyses were preregistered: https://researchbox.org/1192. Please see online Supplemental Information for a) details and links to the preregistrations, data, and analyses (SI.A); b) survey on terminological preference for our autistic participants (SI.B); c) more specifics on methods including images of all trials for both tasks (SI·C); d) specifics about the norming study (SI·D); e) full models of preregistered model and direct comparisons (SI.E) and exploratory analyses (SI·F); f) specifics of analyses testing a role for competition (SI.G).

### 2.1. Participants

80 autistic adults (28 female, 52 male; Mage = 31.7) were recruited via the Asperger/Autism Network and identified themselves as autistic. 80 NT adults (49 female, 31 male; $M_{age} = 42.8$) were recruited via Cloud Research (Litman & Robinson, 2020), and reported themselves to be non-autistic. Gender, proficiency in the Spanish language, and educational attainment were self-reported and subsequently included in exploratory models.

### 2.2. Procedure

All participants completed the flexible meaning extension (FME) and label learning (LL) tasks. The order of tasks was counterbalanced across participants in each group, and the order of trial presentation within each task was randomized for each participant. Both tasks were hosted

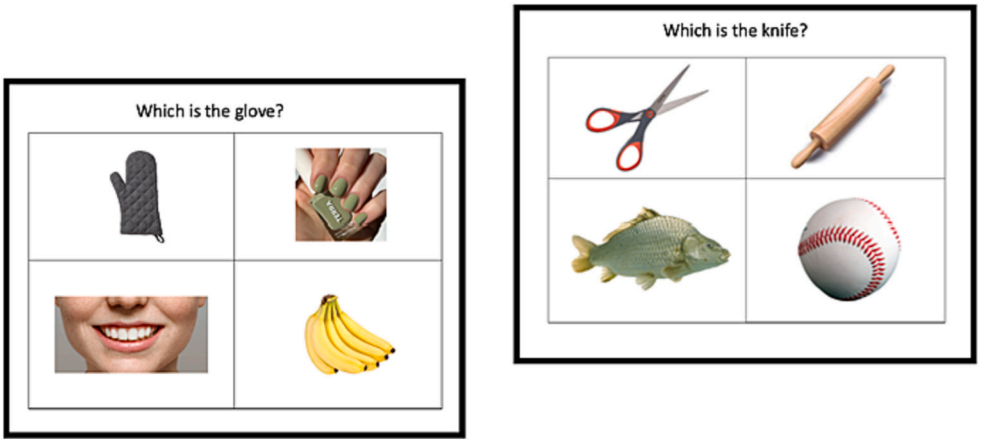


**Fig. 1.** Two example trials used in the Flexible Meaning Extension task. On the left, participants were asked to choose which image was a glove, and on the right, which image was a knife.

on the online, Qualtrics platform and involved no participant-researcher interaction. No time constraints were imposed on responses.

### 2.3. Flexible meaning extension task

Each participant saw six of 14 normed stimulus words (see SI·D for norming details). Each word was presented in two conventional meaning trials and one FME trial. Conventional meaning trials included a target image depicting a conventional meaning of the word; these trials were included to ensure all participants had the requisite prior knowledge of the conventional word meanings to be able to perform the FME task. All participants met the preregistered exclusion criterion (performance above 90% on conventional trials).

The critical FME trials required participants to assign a series of familiar words to plausibly related meaning extensions (Fig. 2).

In each critical FME trial, four distinct options were presented along with the familiar label: the target image, two foil images, and a distractor image. The foils were unrelated to the label, while the distractor shared some characteristic or thematic relation with the label. The norming confirmed that all target images were preferred over the distractor image more than 90% of the time in a *two* alternative forced choice task (see SI·C for full set of stimuli used as targets, distractors, and foils, and SI.D for details of the norming study).

#### 2.3.1. Label learning task

Novel objects and labels were selected from The Novel Object and Unusual Name (NOUN) Database (Horst & Hout, 2016). Participants were initially familiarized with 24 novel objects, presented 4 at a time for 4 s, without labels, in random order (see Fig. 3 [Left]). A written prompt: "Look at these!" appeared at the top of the screen.

Immediately after the familiarization trials, participants saw 8 novel objects, a unique novel label assigned to each, for 4 s apiece (two example exposure trials are provided in Fig. 3 (right side).

At test, participants were asked to assign each novel label to its correct target object in a 4AFC task (Fig. 4). The four options always included the target (correct), a distractor object, and two foil objects. The distractor image had been assigned a different label than the one queried, and served as a target on a different trial. Foil images were witnessed during familiarization but unlabeled. The LL task required no generalization, since each novel label named a single novel object. See SI.C for all stimuli.

## 3. Results

Accuracy on recognition of the conventional meanings of familiar words was very high, confirming that both groups had the requisite prior knowledge of the familiar words' meanings required to potentially perform the FME task accurately ($M$ = 100% for NT, 97.8% for AS). Of interest was performance on the FME and LL trials (Fig. 5).


**Fig. 2.** Fourteen familiar words and corresponding target images used in the Flexible Meaning Extension task. Norming ensured the images were plausibly related to the stimulus words but not commonly labeled by those words.

Every participant scored at or above 50% accuracy on both tasks, where chance was 25%. Ceiling performance on the FME task was reached by 80% of NTs and 29% of AS participants, while ceiling performance on the LL task was met by 19% of NTs and 64% of the AS group. As planned, a generalized mixed effect model predicted accuracy on the basis of an interaction of group (AS vs NT) and trial type (FME or LL), with random slopes and intercepts for subjects and items. Fixed effects were sum coded. The predicted interaction was significant ($\beta$ = 0.75, $z$ = 3.81, $p$ = 0.0001). Direct comparisons revealed that AS

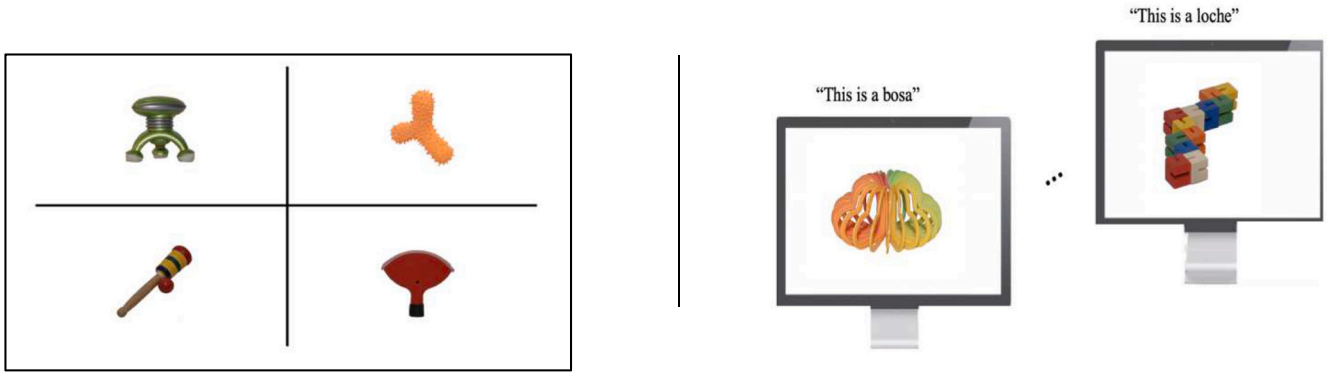


**Fig. 3.** Example familiarization trial (left) and two examples of labeled novel objects witnessed in the exposure phrase (right) of the Label Learning task.


**Fig. 4.** Sample trial in Label Learning task. This task includes the target image (here, *loche)*, two foils that had been witnessed but unlabeled during exposure, and a distractor image that was previously labeled (here, *bosa)*.

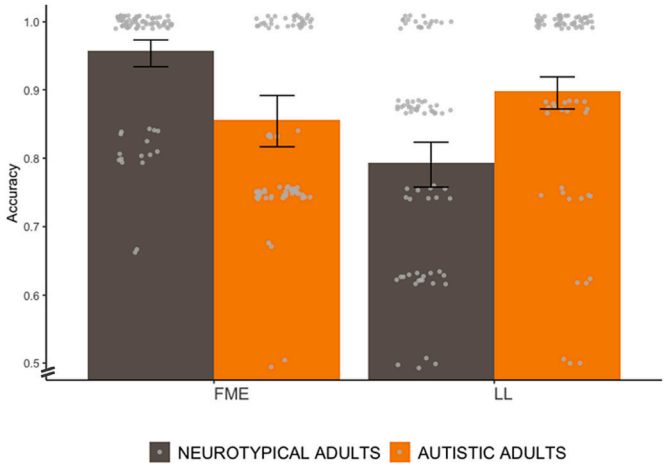


**Fig. 5.** Accuracy on the Flexible Meaning Extension task (left) and the Label Learning task (right) for neurotypical (brown) and autistic adults (orange), with 95% confidence intervals. Grey points represent average accuracy of each participant ($N = 160$).

participants were less accurate than NT participants on the FME task ($\beta = -1.62$, $z = -2.33$, $p = 0.02$; 85.6% vs 95.8%), and more accurate on the LL task ($\beta = 1.49$, $z = 3.10$ $p = 0.002$; 89.8% vs. 79.4%). Within group comparisons likewise revealed clearly distinct performance patterns: AS participants exhibited significantly higher accuracy on the LL task than the FME task ($\beta = 1.83$, $z = 3.08$, $p = 0.002$); in contrast, the NT participants performed significantly lower on the LL task than the FME task ($\beta$ = -1.87, $z = -3.33$, $p = 0.0009$). See SI.E for full model results, and SI·F and SI.G for full exploratory models for results described below.

To explore whether the errors made by the autistic group in the FME task were attributable to extraneous factors, we performed a series of exploratory analyses, using generalized linear mixed models with the maximal effect structure that convergence allowed (See SI.F for full models). Six of the 14 FME items were inspired by co-lexification patterns in Spanish (Floyd et al., 2020), so we tested whether familiarity with Spanish influenced accuracy in this group on this task, and found no evidence that it did ($\beta = -0.02$, $z = -0.10$, $p = 0.92$); neither did we find any evidence for an effect of education level ($\beta = -0.06$, $z = -0.73$, $p = 0.47$); gender ($\beta = 0.20$, $z = 0.33$, $p = 0.74$); or age ($\beta = 0.06$, $z = 0.82$, $p = 0.41$). Given that autistic children are less likely to prioritize shape than neurotypicals, we used the norming data on mean similarity in shape between each word's conventional and extension images to predict accuracy. Similarity in shape (or lack thereof) did not predict accuracy either ($\beta = 0.01$, $z = 1.15$, $p = 0.25$).

Since executive function differences have been observed between AS and NT individuals, we considered that AS errors on FME trials might be due to the need to suppress a more conventional label for the target image: i.e., in order to successfully identify an image of a scissors as a *knife*, it may be necessary to suppress the competing word, *scissors*. To address this, we calculated the strength of competition from conventional labels by calculating Shannon H entropy scores, based on spontaneous labeling data from the norming data. A generalized linear mixed models with subject and item as random effects failed to show any influence of competition ($\beta = 0.81$, $z = 1.02$, $p = 0.31$).

## 4. Discussion

The Flexible Meaning Extension task and Label Learning tasks are broadly comparable: both are 4AFC tasks and both require assigning words to object images in new ways. Results show that the autistic adults performed significantly better than the NTs on the LL task, which did not require the flexible extension of meanings (see also Norbury, Griffiths, & Nation, 2010). Critically, and as predicted by the idea that language should be affected by autistic individuals' generalization differences, autistic adults were significantly more challenged than the NTs on their ability to flexibly extend familiar words to related entities. Moreover, analyses within each group revealed that autistic individuals performed

better on the LL task than the FME task, and the neurotypical adults displayed the opposite pattern.

Potential explanations for the current results that do not rely on generalization differences in the two groups are undermined by various aspects of the design or analyses. The autistic group's especially strong performance on the LL task undermines potential appeal to differences in executive function, given that the LL task requires focused attention and working memory, two key aspects of executive function. Moreover, the degree of competition from a more conventional label showed no influence on accuracy. Neither can the difference in performance be attributed to greater fatigue or distraction in one group on either task, since presentation of FME and LL tasks was counterbalanced across participants.

The group difference in performance on the FME task is not attributable to differences in prior knowledge, since both groups identified the conventional meanings of each of the familiar words at near ceiling levels. The effect cannot be attributed to a failure of the autistic adults to understand the pragmatics of the task, since while they performed significantly lower than the NT group, they all performed well-above chance. Exploratory analyses revealed no evidence that the reduced performance on the FME task was predicted by education, age, gender, or familiarity with Spanish. Finally, the study took place entirely online, without any person-to-person interaction, eliminating the possibility that the social demands of a research setting influenced performance.

We had predicted autistic adults would underperform neurotypicals on the FME task and perform equivalently on the LL task. The fact that our autistic adults *outperformed* neurotypicals on the LL task was not anticipated. Since the autistic and neurotypical participants were recruited from two different platforms, the autistic participants' strong performance on the LL task may potentially be due to any of a number of factors including stronger motivation, attention, or IQ. A recent meta-analysis has found that autistic individuals recruited for online studies tend to be more educated and less likely to have intellectual disabilities than autistic individuals generally (Rødgaard, Jensen, Miskowiak, & Mottron, 2022). If our autistic participants outpaced our neurotypicals on any of these dimensions, however, it may explain their strong performance on the LL task, but it would make their underperformance on the FME task all the more remarkable.

Alternatively, it may be that strength in associating and retrieving labels with single meanings tends to be a particular area of strength for verbally able autistic individuals: To compensate for semantic memories that may be less clustered together and thereby more difficult to recall, verbally able autistic adults may rely more on episodic memory for language (recall the epigraph from Temple Grandin). While episodic memory retrieval is not considered an area of strength among autistic individuals generally, it has been argued to be at least comparable to neurotypicals when contextual support is provided (Norris & Maras, 2022). Moreover, it is possible that stronger memory recall is (or becomes) an area of strength among verbally able autistic adults. Future research is needed to investigate a potential relationship between memory and language to determine whether stronger memory serves as a compensatory mechanism for the reduced tendency to flexibly generalize among verbally able autistic individuals.

Autism refers to a wide range of phenotypes and we do not expect all autistic individuals to be affected by challenges in extending word meanings, and certainly not to the same degree (McCormick et al., 2020; Tager-Flusberg, 2004). Indeed, while the current results demonstrate a significant group-level difference, 29% of autistic adults performed at ceiling on the FME task. We could not examine individual differences within each group because we did not collect supplementary metrics (e.g., diagnosis history, language history, vocabulary, IQ), although we aim to in future work. The fact that skill in extending word meanings is affected at the group level, even among verbally able autistic adults, raises the possibility that individuals with less verbal ability may be more impacted. The current FME task included only concrete words extended to new concrete entities; while this is a limitation of the current work, it also suggests that the implications of a difference in flexible meaning extension are potentially far reaching. In fact, autistic individuals' tendency to struggle with metaphorical extensions and sarcastic or ironic interpretations (Morsanyi, Stamenković, & Holyoak, 2020) may stem from the same challenge identified here.

Insofar as new uses of familiar words are ubiquitous in natural language interactions, interventions aimed at increasing skill in this domain are worth exploring as a complement to interventions that emphasize social cognition and/or executive function (see also Naigles et al., 2013; Naigles & Tek, 2017). Future work is required to determine whether challenges in flexible meaning extension are relevant to children with developmental language disorders (Field, Allen, & Lewis, 2016; Jones, 2003). This possibility is suggested by the finding that children with DLD, like autistic children, demonstrate delayed prioritization of shape in early noun learning (Gladfelter & Barron, 2020; Perry, Kucker, Horst, & Samuelson, 2022).

At the same time, the current findings generalize prior work that has found that, in comparison to NTs, autistic children are less likely to appropriately prioritize shape when generalizing novel labels of concrete entities (Collisson et al., 2015; Potrzeba et al., 2015; Tek et al., 2008; Tovar et al., 2020). That is, we find no evidence that the current effect results from a failure prioritize the shape of objects. Instead, we suggest that both a reduced shape bias in autistic children and the current results reflect a broader difference in generalization, which continues to impact autistic adults at the group level. Given the complex and dynamic nature of word meanings in natural language, skill in extending meaningful categories in new ways merits close attention.

Other prior work had found that a group of autistic children showed no evidence of taking advantage of semantic relatedness among meanings when learning novel words, while neurotypical children did (Floyd et al., 2021). The current work demonstrates that even verbally able autistic adults are more challenged than neurotypicals in recognizing related plausible new meanings of familiar words. This therefore extends the impact of generalization differences well beyond childhood and beyond the realm of novel word learning to the domain of language comprehension. Because the semantic relatedness in the FME task did not depend on perceptual similarity, the current results extend language-relevant generalization differences among autistic individuals beyond visual or auditory perception.

The current work suggests an explanation for long-standing observations about unconventional aspects of autistic individuals' speech, namely that it often contains more repetitions and less productive extensions than neurotypicals' speech (for review see Luyster, Zane, & Wisman Weil, 2022). To the extent that autistic individuals struggle to flexibly extend categories, including the complex categories of word meanings, their language can be expected to be less flexible and more rigid.

Persistent challenges in flexible generalization may help contextualize mixed results that extend beyond research on language. For example, autism has been claimed to be a prediction disorder (Sinha et al., 2014; Van de Cruys et al., 2014), although the evidence is mixed (Cannon, O'Brien, Bungert, & Sinha, 2021; Prescott et al., 2022). Other studies have found autistic individuals rely less on priors in perceptual and social tasks than neurotypical individuals (e.g., Pellicano & Burr, 2012; Von Der Lühe et al., 2016), although again, a recent meta-study finds the evidence to be mixed (Chrysaitis & Seriès, 2022). We speculate that it may be useful to reanalyze previous results in terms of what is required in each case to create a prediction or make use of priors. Using prior knowledge to predict the future requires recognizing that a current event is relevantly similar to some prior event; without this, there would be no basis for a prediction, as priors would not be recognized as relevant. That is, to appreciate that an event or stimuli, A, will be followed by another event or stimuli, one needs to recognize that the current situation or stimuli, A', is relevantly similar to A. The task may be more or less challenging, depending on how direct the relationship is between A and A'.

## 5. Conclusion

The growing appreciation that word meanings must be routinely extended to apply in new contexts, combined with the observation that autistic individuals attend more to specifics than neurotypicals in domains outside of language, motivated the hypothesis tested in the current work. As predicted, the autistic group performed significantly less accurately on the task that required them to flexibly extend the meanings of familiar words in plausible but unconventional ways, while they significantly outperformed their neurotypical peers on the similarly demanding novel label learning task that did not require flexible extension. Exploratory analyses revealed no support for alternative explanations in terms of differences in prior knowledge of the familiar meanings, understanding of task pragmatics, executive function or competition effects, education level, familiarity with plausible extensions from knowledge of Spanish, age, gender, or similarity (or lack of similarity) in shape of the items. Future work is required to determine whether the difference in flexible meaning extension applies to aspects of language beyond the word level. A deeper appreciation of the role of flexible extensions in language offers both a deeper understanding of natural language and potentially a novel way to understand communication challenges faced by autistic individuals.

## CRediT authorship contribution statement

**Nicole Cuneo:** Conceptualization, Data curation, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Sammy Floyd:** Conceptualization, Methodology, Writing – review & editing, Data curation. **Adele E. Goldberg:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

## Data availability

Preregistrations, data, R scripts are available here: https://researchbox.org/1192

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2023.105691.

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