Autistic and non-autistic adults use discourse context to determine a speaker's intention to request

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Abstract

Purpose: The current study focuses on how autistic adults utilize context to determine whether ambiguous utterances (e.g., "I'm thirsty") are intended as indirect requests or as literal comment/questions. Two questions are addressed: (1) How do autistic adults compare to neurotypical adults in using context to interpret an utterance's intention as either literal or a request? (2) What cognitive mechanisms correlate with indirect request interpretation, and are these different for participants in each group?

Methods: Twenty-five autistic and 23 neurotypical college students participated, engaging in an online experiment where they read narratives that ended with utterances open to literal or request interpretations, based on context. After each narrative, participants selected the best paraphrase of the utterance from two options, literal vs. request. Following this task, participants completed two mentalizing measures (a false belief and emotion-identification task) and several executive functioning tests.

Results: The best model for predicting paraphrase choice included scores on the emotion-identification task and context as main effects, along with the interaction between both. Participants with higher mentalizing scores were more likely to provide correct paraphrases. Models including group as a main effect and/or interaction were not better at fitting the data, nor were any models that included executive functioning measures as main effects or interactions.

Conclusion: Mentalizing scores, but not autism diagnosis, predict how adults infer whether an utterance is a request. Findings suggest that autistic adults use context similarly to neurotypical adults when interpreting requests, and that similar processes underlie performance for each group.

Introduction

English speakers can choose from several utterance types when they want to perform a directive, a speech act wherein the speaker's intention is to command or request (Searle, 1975). These include imperatives (e.g., "Turn on the heater."), interrogatives (e.g., "Isn't it cold in here?") and declaratives (e.g., "It's cold in here."). The latter two forms, interrogatives and declaratives, are referred to as "indirect requests," since, unlike imperatives, the form of the locutionary act (i.e., the linguistic structure) belies illocutionary force (i.e., the intended meaning). Although imperatives more straightforwardly convey a speaker's intention, English speakers commonly opt for indirect requests, instead, as they are perceived as being more polite (Brown & Levinson, 1987; Lakoff, 1973). However, being polite through indirectness presents a potential processing challenge, as the listener must recognize that the utterance's form belies its intention to direct. If a listener does not recognize this, they may respond in an undesirable way. For example, if a speaker asks, "Isn't it cold in here?", a listener may answer the question (e.g., "Yes, it is.") rather than perform the intended action (i.e., turn on the heater). Thus, a listener's ability to recognize that non-imperative forms (i.e., interrogatives and declaratives) can be used to convey an imperative intention is important for successful communication.

Some indirect requests are easier to interpret than others. In the mid-1970s, Ervin-Tripp introduced a framework aimed at categorizing different types of indirect requests (Ervin-Tripp 1976; 1977). Forms such as, "Can you turn on the heater?" were labeled embedded[1] imperatives because the structural imperative (i.e., "turn on the heater") is preserved within the utterance. When these forms begin with a modal (e.g., "can"), researchers have traditionally referred to

[1] We have changed "imbedded" – which is Ervin-Tripp's original spelling of the word – to "embedded" for the rest of the paper.

embedded imperatives as “conventionalized” indirect requests (Ackerman, 1978; Gibbs, 1986). This label reflects the fact that listeners seem to automatically interpret embedded imperatives beginning with “can” or “could” as requests rather than yes/no questions when they are presented in a context that allows for a directive interpretation (Gibbs, 1986). In support of the notion that embedded imperatives are easily recognized as requests, research finds that typically developing children successfully understand embedded imperatives as early as age two (Babelot & Marcos, 1999; Bucciarelli et al., 2003; Shatz, 1978a; 1978b).

There are other types of indirect requests that may pose a greater challenge for successful comprehension. For example, speakers sometimes produce utterances with embedded imperatives but no initial modal (e.g., “I wish someone would turn on the heater.”), other times speakers us use declaratives or interrogatives that do not include the structural imperative in the surface form at all (e.g., “I wish the heater was on.”), and sometimes they even fully exclude all parts of the underlying imperative (e.g., “It’s cold in here.”). These forms have been conceptualized as “non-conventionalized” requests, to directly contrast them with “conventionalized” forms, given that they employ utterances that are not routinely directive (Ackerman, 1978). The latter two types – in which the structural imperative does not appear in the surface form at all – arguably presents the most challenger to listeners. Ervin-Tripp referred to such forms as “hints” or “question directives,” depending on whether the surface form is declarative or interrogative, respectively (Ervin-Tripp, 1976; 1977). For the sake of simplicity, we will refer to any type of indirect request that does not involve most or all the structural imperative as “hints,” regardless of whether their surface form is a question or statement.

Given that the default interpretation of hints is not necessarily imperative, listeners must rely on context and inferencing skills to determine the speaker’s intended meaning. For example:

A driver and a passenger are in a car that has a broken heating system, and the passenger says, "It's cold in here." The interpretation of this utterance depends on what each interlocuter knows about the heater and about each other's background knowledge (Trott & Bergen 2018; 2020). If the passenger knows the heater is broken (and the driver knows the passenger knows this), "it's cold in here" is likely intended as a comment, and the driver will interpret it as such. However, if the passenger is unaware of the heater's status (and the driver knows they are unaware), the same utterance could be intended and interpreted as a request. Accordingly, research has shown that successful interpretation of hints develops alongside theory of mind (ToM) skills. ToM describes the ability to infer the mental states of others. In laboratory settings, ToM ability is often assessed through inferencing tasks like comprehending false beliefs. Research finds that ToM skills are developed gradually in typically developing children, with certain ToM subskills, like understanding false beliefs, not emerging until children are between the ages of four and six years (Wimmer & Perner, 1983). Similarly, children start understanding non-conventionalized indirect requests around this age, although not perfectly (Ackerman, 1978; Bernicot, Laval, & Chaminaud, 2007; Bernicot & Legros, 1987; Bucciarelli et al., 2003; De Mulder, 2015; Elrod, 1987; Ledbetter & Dent, 1988; Leonard et al., 1978; Liebling, 1998; Spekman & Roth, 1984).

Research on neurotypical (NT) adults has also provided evidence that ToM skills are related to indirect request comprehension (Trott & Bergen, 2018; 2020; van Ackeren et al., 2012). Trott and Bergen (2018) tested NT adults on their ability to determine whether an utterance was a comment/question or a hint, depending on the speaker's state of mind in a given context. In their experiment, participants read short narratives that ended with an utterance that could be interpreted as a comment/question or a request, depending on whether the speaker was aware of circumstances making a request in/felicitous. After reading each narrative, participants selected the best paraphrase of the utterance from two options, literal (i.e., comment/question) vs. request. It was found that participants who performed less accurately on the indirect request task had lower mentalizing scores, leading authors to conclude that ToM skills underlie the successful interpretation of non-conventionalized requests.

Indirect Request Comprehension in Autism

The link between ToM and indirect-request comprehension could suggest that autistic[2] listeners would show differences in their interpretation of indirect requests (especially hints) since differences in ToM have long been touted as a feature of autism (Baron-Cohen, 2000; Baron-Cohen et al., 1985; cf. Milton, 2012). Accordingly, researchers have used differences in ToM to account for why autistic individuals find other types of non-literal language, such as irony, challenging (e.g., Deliens et al., 2018; Happé, 1993). Despite indirect requests being similarly non-literal (e.g., the literal answer to "Isn't it cold in here?" is "yes" or "no"), there has been relatively limited work examining how autistic individuals interpret indirect requests, and particularly the study of hints. The following paragraphs provide a summary of this research.

Research exploring how autistic individuals interpret embedded imperatives has yielded fairly consistent results, with both autistic children and adults being successful with these forms (Deliens et al., 2018; Kissine et al., 2012; Ozonoff & Miller, 1996; Paul & Cohen, 1985). The earliest of these studies, conducted by Paul and Cohen (1985), found that autistic adults with a mental age of 4-7 years were successful at recognizing that imperatives (e.g., "Can you color the circle blue?") can function as indirect requests. Since then, these results have been replicated

[2] For this paper, we intentionally use identity-first language (i.e., autistic person) to be consistent with the preference of the autism community (Brown, 2011).

with both autistic children (Kissine et al., 2012) and autistic adults with average IQ scores (Deliens et al., 2018; Ozonoff & Miller, 1996). However, an interesting finding has appeared in adult populations, suggesting that autistic adults might struggle with utilizing context during these interpretations. In Ozonoff and Miller (1996), autistic participants were more likely to interpret utterances beginning with, "Can you...?" as requests, even in contexts that biased a direct/literal interpretation. Similarly, Deliens and colleagues (2018) found that autistic participants were significantly more likely to interpret utterances beginning with, "Is it possible...?" as requests than NT participants. While Deliens and colleagues (2018) did not speculate on these findings, Ozonoff and Miller (1996) interpreted their findings as indicating the autistic individuals have difficulty utilizing context to determine speaker meaning. This corresponds with the Weak Central Coherence (WCC) theory, which hypothesizes that autistic individuals tend to focus more on the specific and local (in this case a specific utterance's form), rather than integrating information from the surrounding, global context to interpret meaning (Happé & Frith, 2006). Findings from hints, which require listeners to incorporate context, could shed light on how autistic individuals are utilizing context when interpreting indirect requests.

As far as we are aware, research on autistic people's understanding of hints has only included children, not adults. MacKay and Shaw (2004) compared how autistic and NT children (ages 8-11) interpreted hints by having participants listen to short stories that ended with an utterance with an ambiguous intention, such as, "That cake looks delicious," and asking them to explain what the speaker meant. In all trials, these utterances were intended to be hints; that is, the context made it clear that the speaker's intention was to request, not to comment. Results indicated that autistic children were able to explain speaker intention similar to NT children, suggesting that they recognized that the function of the utterances was to request. However, because all target utterances were intended as requests, results do not shed light on how autistic children use context to interpret the same utterance in different ways. For example, in certain contexts (e.g., at a party) the utterance, “That cake looks delicious,” can be interpreted as a request, while in other contexts (e.g., watching a baking show) it can only be interpreted literally, as a comment. Thus, it is possible that MacKay and Shaw (2004)’s findings mirror those from Ozonoff and Miller (1996), discussed earlier, where autistic individuals interpreted ambiguous utterances as requests, regardless of context. If so, we predict that group differences would be discovered if participants had to incorporate discourse context – particularly context manipulating mental states of the speaker and listener – in order to determine whether the *same* utterance is intended as a request or not in a given situation.

Kissine and colleagues (2015) incorporated just this manipulation by recording children’s responses to utterances that were presented in both directive (i.e., hint) and literal (i.e., comment) contexts. For this study, participants engaged with a Mr. Potato Head toy, with two experimenters present – one interacting directly with the child and the other nearby. In the directive context, the interacting experimenter said to the child, “Oh, he has no hat!” as a request to put a hat on the toy. In the literal context, the same utterance (“Oh, he has no hat!”) was again produced by the experimenter while the child engaged with Mr. Potato Head, but the discourse context biased a non-request interpretation, by manipulating both the utterance’s addressee (the comment was directed towards another adult in the room) and the utterance’s referent (the comment was made about a character in picture). Results indicated that autistic children were successful at responding to the intention of these utterances, complying with the hint in the directive context and refraining from interpreting it as a request in the literal context. The authors concluded that their findings not only confirmed those of MacKay and Shaw (2004), showing that autistic children can interpret hints, but also built on those findings by revealing that autistic children can use discourse context to distinguish a speaker's intention. However, there were some aspects of Kissine and colleagues (2015) that make the interpretation of findings less straightforward. The literal context's adjustments to addressee and referent provided multiple cues to participants that the statement was not intended as a request, making it unclear which cue children relied on for interpretation. The change of addressee particularly complicates the interpretation of children's responses, as children could correctly "comply" to the utterance by not putting a hat on Mr. Potato Head, regardless of their interpretation of the speaker's intention. Expanding on this, because "compliance" involved not doing or saying anything in response, a child who ignored these comments altogether (a behavior that seems perfectly legitimate when someone is talking to someone else) would get credit for interpreting successfully. To obtain more conclusive evidence that autistic children can effectively utilize context to determine speaker intention, it is necessary that both the non-literal (request) and literal (comment) forms are directed towards the same person, and that a participant's interpretation can be unambiguously reflected by their response, not a lack of response.

A more recent study by Marocchini and colleagues (2021) aimed to investigate the relationship between ToM and indirect request interpretation in both NT and autistic children (ages 9-12). To assess this, participants completed first- and second-order ToM tests, in addition to an indirect request task. For their indirect request task, children were presented with a drawing and asked to help the experimenter (who had seen the picture before, but could not see it during the task) to recreate it. Experimenters used both imperatives (e.g., "Tell me what color the grass is.") and hints (e.g., "I don't remember the color of the grass.") to elicit information from participants. Overall results indicated no main effect of group, suggesting that autistic children were as successful as their NT peers at interpreting indirect requests. This is noteworthy because the NT group had significantly higher scores on the ToM tests. This contradicted the authors' initial hypothesis that ToM scores would correspond with indirect request compliance, leading them to conclude that while NT children may rely on ToM to interpret hints, autistic children use alternative interpretative strategies. The authors suggest that autistic children may use certain linguistic cues, such as the phrase *color of the grass,* to guide them into producing a correct response, even if they do not truly recognize the speaker's intention.

While the findings from Marocchini and colleagues (2021) fill in some gaps left by previous research, there remain further questions. First, similar to MacKay and Shaw (2004), Marocchini and colleagues (2021) did not vary the context nor the intent of the target utterances, so that all items were only presented once, and always with a directive intention. Thus, we cannot determine how groups would use context to determine whether a given utterance was meant as a request or a literal comment/question. Second, as in Kissine and colleagues (2015), participants' non-responses were considered meaningful in Marocchini and colleagues (2021). In this case, a lack of response was interpreted as children *misunderstanding* the speaker's intention to request, whereas in Kissine and colleagues (2015) non-responses to comments were interpreted as children *understanding* them. As we outlined above, there are many reasons that children may remain silent that have little to no bearing on whether they recognize a speaker's intent. Finally, since all the research on hint interpretation in autism has included children (and not adults), it is difficult to tease apart development from diagnostic group. That is, group differences may merely reflect developmental trends that disappear when participants reach adulthood.

The Current Study

The current study addresses gaps identified in previous research by examining how autistic adults use context to determine whether an utterance could be an indirect request. Specifically, we will focus on the interpretation of hints, given that these forms do not encourage a default request interpretation the way that conventionalized requests do. Further, while there is a substantial amount of evidence indicating that autistic individuals are successful at interpreting embedded imperatives (Deliens et al., 2018; Kissine et al., 2012; Ozonoff & Miller, 1996), there is no consensus on how autistic individuals (particularly adults) interpret requests that do not include the form and/or semantic components of the underlying imperative.

The current design replicates Trott and Bergen (2018; 2020)'s studies on NT adults, where participants read short narratives that end with a speaker producing an ambiguous utterance, and then participants select an appropriate paraphrase for the utterance. Because participants must explicitly provide an interpretation for each utterance, we avoid the pitfalls of using participants' response behavior (or lack thereof) as a window into their understanding of speaker intention.

Two questions will be examined: (1) How do autistic adults compare to NT adults in using context to interpret an utterance's intention as either a request or a comment/question? (2) What cognitive mechanisms correlate with performance on indirect request interpretation, and are these different for participants in each group? Regarding the first question, it is difficult to form a hypothesis based on the existing literature. While results from Ozonoff and Miller (1996) suggest that autistic adults may show differences in using context to guide the interpretation of conventionalized requests vs. literal questions, Kissine and colleagues (2015) found that autistic children adaptably used context to distinguish hints from comments. Because we suspect that findings in the latter study were influenced by the fact that children had multiple cues to drive interpretation (including changes in the addressee), we tentatively predict that autistic adults will show less sensitivity to context. This hypothesis is also motivated by two other factors. First, Trott and Bergen (2018; 2020) found that ToM scores correlated with performance on their indirect request measure, and we predict that autistic participants will score lower on ToM measures in the current study. Second, the WCC theory suggests that autistic participants may show differences in how they utilize the global discourse context to determine the meaning of a given sentence (Happé & Frith, 2006). In fact, this may help explain the Ozonoff and Miller (1996) findings, where autistic adults were more likely to interpret utterances as request, regardless of discourse context.

The second research question explores the cognitive constructs that underlie indirect request interpretation in autistic and NT adults, and whether different mechanisms may be involved for each group. One of the cognitive constructs we measure is ToM, since previous research has suggested a link between ToM and indirect request comprehension for NT adults and some NT children (Marocchini et al., 2021; Trott & Bergen 2018; 2020; van Ackeren et al., 2012). Based on their findings, we hypothesize that ToM scores will predict indirect request interpretation performance for NT adults who participate in the current study. Regarding the autistic group, it is again difficult to make a prediction. Marocchini and colleagues (2021) found that ToM scores did not predict performance on an indirect request task for autistic children, suggesting that autistic individuals may use strategies aside ToM to interpret indirect requests correctly. However, this finding may only reflect how autistic *children* – not autistic adults – perform such tasks. Although autistic children tend to score lower than NT children on ToM tests, these differences decrease with development (Happé, 1995; Scheeren et al., 2013; Steele et al., 2003). In fact, some autistic adults score similarly to NT adults on certain ToM measures (see Gernsbacher & Yergeau, 2019 for a review). Therefore, while autistic children may rely less on ToM to interpret requests, autistic adults may use similar strategies to NTs.

In addition to ToM, we also explore how executive functioning (EF) relates to indirect request interpretation for both groups. EF refers to a set of cognitive processes that are necessary for managing thought and behavior. Core subcomponents include inhibition, attention shifting, and working memory (Miyake et al., 2000). Because some previous research has suggested that indirect request interpretation may function independently of ToM for autistic children (Kissine et al., 2015; Marocchini et al., 2021), it is possible that other cognitive mechanisms may underlie their interpretation. We offer EF as one possibility, since the ability to incorporate the surrounding/preceding discourse into the interpretation of a sentence arguably relies on attentional allocation to relevant aspects of the discourse, memory of those relevant aspects, and inhibition of irrelevant information. Inhibition is also likely involved in determining that a sentence is meant as a request rather than a literal comment/request (and vice versa), since one must inhibit the competing interpretation. In support of the fact that indirect request can involve EF, at least for certain populations, Champagne-Lavau and Joanette (2009) conducted a study examining the roles of ToM and EF in interpreting indirect requests in adults with right-hemisphere brain damage. While EF scores alone did not predict performance on indirect request measures, the authors found that a combination of ToM and EF best accounted for participant performance.

Methods

Participants

English-speaking college students were recruited via university bulk email. This study was approved by the Institutional Review Board at XXX; all participants provided email consent to participate in research.

The autistic (AUT) group consisted of 25 young adults (age range = 18-25 years, mean age = 20.0). In the AUT group, 14 adults reported being assigned the female sex at birth, and 11 adults reported being assigned the male sex at birth. Current gender identities included: transgender woman (4%), transgender man (4%), agender (4%), nonbinary (24%), cisgender woman (24%), cisgender man (36%), and 4% of autistic participants identified as other (not listed). The racial and ethnic backgrounds of the AUT group included: Native American (4%), Black or African American (8%), Latinx (16%), White (60%), and 12% identified as being two or more races.

The AUT group included both individuals who had been officially diagnosed as autistic/having autism (n = 11; 5 males), as well as individuals who were self-diagnosed (n = 14; 6 males). We chose to include individuals who diagnosed themselves as autistic due to the protracted diagnosis of autism in adulthood (Lewis, 2017). Ten autistic participants (1 male and 9 females) reported co-occurring diagnoses of ADHD. All participants in the AUT group demonstrated scores within the autistic range (i.e., $\geq$ 26; Woodbury-Smith et al., 2005) on the Autism Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, et al., 2001). Average AQ scores for each group can be found in Table 1.

[Table 1 here]

The neurotypical (NT) group consisted of 23 young adults (age range = 18-24 years, mean age = 19.8). In the NT group, 13 adults reported being assigned the female sex at birth, and 10 adults reported being assigned the male sex at birth. Current gender identities included:

transgender woman (4.3%), nonbinary (8.7%), cisgender man (39.1%), and cisgender woman (47.8%). The racial and ethnic backgrounds of the NT group included: Asian (4.3%), Black or African American (8.7%), Latinx (8.7%), White (65.2%), and 13% identified as being two or more races.

Because all participants were currently pursuing either bachelor's or master's degrees at an institution of higher education, we assumed them to have functional language skills in at least typical ranges. However, as the indirect request task specifically required participants to read and understand short passages, we included passing scores on a 5-question reading comprehension screener adapted from the Test of Reading Comprehension-Fourth Edition (Brown et al., 2009) as an inclusion criterion.

Initially, 55 participants were recruited for the experiment, but only 48 were included in the data analysis. Four participants were excluded for their AQ scores: One AUT participant because their score was well below the cut-off for autism, and three NT participants whose scores fell within the autism range. Additionally, two participants (1 AUT and 1 NT) were excluded due to incomplete experiments, and one NT participant was excluded for failing the reading comprehension screener.

Materials

Indirect Request Task

The stimuli for the indirect request task consisted of eight pairs of short narratives, originally created by Trott and Bergen (2018), and minorly adapted by the current authors after feedback from pilot participants. Each narrative pair described the same scenario, in which the participant (addressed as "you") interacts with a character in the story who ultimately produces an utterance that could be interpreted as either a comment/question or a request, depending on context (Appendix A). The manipulation within each narrative pair involved whether speaker was aware of circumstances making a request in/felicitous. For example: You and your friend are riding in a car, and your friend says, “I’m cold.” Depending on whether your friend knows the car’s heater is broken – information that is explicitly supplied in the narrative – the final utterance could be interpreted as a comment or a request. Thus, there were two version of each narrative: 1) A *Speaker Aware* version, in which the speaker knew information making a request infelicitous (e.g., the car’s heater is broken); 2) A *Speaker Unaware* version, when it was clear that the speaker was not privy to that information (Trott & Bergen, 2018).

Participants were randomly assigned to one of two lists, counterbalanced for which version of each narrative they read. Each participant read eight passages, presented in a random order, with an equal number of narratives in the Speaker Aware and Speaker Unaware conditions (four in each). After reading each narrative, participants were required to choose the best paraphrase of the speaker’s utterance from two options. One paraphrase option represented a literal interpretation of the utterance (e.g., I’m really cold; it’s too bad the heater is broken.), while the other was a request, formulated as an embedded imperative (e.g., Could you turn on the heater?). The paraphrase judgement options were presented in random order. The experiment software automatically recorded the amount of time participants spent on each task.

Theory of Mind Measures

Before/after completing the request task, participants also completed two theory of mind measures. The first measure assessed mental state reasoning through a false belief task. For this task, participants were presented with three short stories and asked 1-2 false belief questions after each (Appendix B). The false-belief questions tested both first- and second-order ToM, assessing how participants attribute mental states to characters and use that information to predict other mental states and actions. The second measure was the Reading the Mind in the Eyes test (RME; Baron-Cohen, Wheelwright, Hill, et al., 2001). The RME assessed mental state decoding by requiring participants to identify mental states based on visual information from the eyes.

It is worth noting that these measures differed from the ToM measure used in Trott and Bergen (2018; 2020). The measure utilized in their experiment, called the Short Story Task (SST; Dodell-Feder et al., 2013), required participants to answer mentalizing and comprehension questions based on a short story by Ernest Hemingway. Mentalizing was measured by observing participants' spontaneous and prompted use of mental state terms. The authors labeled spontaneous use as "mental state inferencing" and prompted use as "mental state reasoning." It was found that only mental state reasoning was predictive for the indirect request task. However, mental state reasoning was highly correlated with reading comprehension, making it difficult to know which construct was underlying performance on the request task. To help tease apart the contribution of reading comprehension and ToM we decided to include a visual task that is designed to index mental state understanding (the RME test) that did not involve narrative comprehension in addition to one that did. As to the latter task, we elected to replace the SST with a more straightforward false belief task, as the SST is lengthy.

Executive Functioning Measures

Three EF tasks were administered to evaluate inhibition, attention shifting, and working memory. Inhibition was assessed using a flanker task (Eriksen & Eriksen, 1974), attention shifting was measured through the Wisconsin Card Sorting Task (WCST; Berg, 1948), and working memory was evaluated using an n-back task.

Procedure

The experiment was conducted online, utilizing jsPsych (de Leeuw, 2015) for implementation. Upon completing the demographic survey and reading comprehension screener, participants engaged in the false belief task. Next, participants completed the indirect request task. Then, the RME was administered as an additional ToM measure. Following the RME, participants responded to the AQ. Finally, the participants were administered the three EF tasks. The experiment took an average of 40 minutes to complete, and participants received compensation ranging from $15 to $20 for their participation.

Statistical Analysis

All analyses were performed in R (R Core Team, 2023). Generalized linear mixed-effects models were run using the *lme4* package (Bates et al., 2015).

Results

First, we tested whether the narrative context (speaker aware vs. speaker unaware) predicted participants' interpretations. To do this, we built a simple model with Interpretation (literal vs. request) as the dependent variable, Condition (speaker aware vs. speaker unaware) as a fixed effect, and a random intercept for Item. Results from the simple model revealed that Condition significantly predicts whether participants choose a literal or request interpretation [$\beta = 3.80$, $SE = 0.33$, $p < .001$]. All models described in the following contain these same effects – a fixed effect for Condition and a random intercept for Item – with additional fixed effects, and then we compare the fit of those models to the original, reduced model with Condition as the only fixed effect.

Our first research question focused on comparing groups on how they utilize speaker awareness to interpret an utterance as either a request or a comment/question. To do this, we added Group as a fixed effect to the null model, along with the interaction between Group and Condition. We then compared this model to the reduced model. Results revealed that adding Group and the interaction between Group and Condition did not improve model fit compared to the original, reduced model [$\chi^2(2) = 0.73$, $p = .69$]. Table 2 presents the proportion of literal and request responses by the two groups in each condition.

[Table 2 here]

In both conditions, AUT adults and NT adults exhibited similar response patterns. Specifically, in the Speaker Aware condition, both groups more often selected a literal (comment/question) interpretation, while in the Speaker Unaware condition, both groups more often selected a request interpretation [AUT: $\chi^2(1) = 100.83$, $p < .001$; NT: $\chi^2(1) = 100.83$, $p < .001$].

Our second research question focused on assessing what cognitive mechanisms predict performance on indirect request interpretation. Table 3 reports the groups' mean scores on both ToM tasks and the three EF tasks.

[Table 3 here]

Notably, no significant differences were found between the groups on the false belief task or the RME. For EF, groups performed similarly except on the n-back task (i.e., working memory), where the AUT group scored significantly higher. While the groups exhibited overall similarities in their performances on most of these measures, the fundamental aim of our second research question was to determine whether any of these measures have predictive value for individuals' performance.

We began with the first ToM test scores, the False Belief task, by adding in scores from this task as fixed effects, along with the interaction between Condition and False Belief scores. We then compared this model to the reduced model, which was the as-yet best-fitting model. Results revealed that adding scores from the false belief task, along with the interaction, did not improve model fit compared to the reduced model [$\chi^2(2) = 0.72$, $p = .70$].

We then moved on to our second ToM measure, the RME. We added RME scores as fixed effect to the as-yet best-fitting model, along with the interaction between Condition and RME scores. We then compared this model to the reduced model. Results revealed that adding RME scores, along with the interaction between RME and Condition, significantly improved model fit, as compared to the model that included Condition as the only fixed effect [$\chi^2(2) = 8.79$, $p < .01$] (Table 4).

[Table 4 here]

To explore the significant interaction effect for Condition and RME scores, we ran a post-hoc analysis, where we flipped the model, making RME scores the outcome variable, and Condition and Interpretation the predictor variables, again with Item included as a random effect. We then calculated Tukey HSD tests using the emmeans package in R-Studio (Lenth, 2023) to compare RME scores for participants who selected one or the other paraphrase choice for one or the other condition. Results revealed marginally significant differences in RME scores for two comparisons. First, participants who correctly recognized that utterances produced by *aware speakers* were intended as literal comments/questions (95% *CI* for RME scores = [26.8, 28.2]) had marginally significantly higher RME scores than participants who incorrectly thought that *unaware speakers* were making literal comments/questions (95% *CI* for RME scores = [24.5, 26.8], $t = 2.40$, $p = .08$). See Figure 1.

[Figure 1 here]

Second, this latter group of participants – those who interpreted unaware speaker's statements as literal comments/questions – also had marginally significantly lower RME scores than those who recognized that unaware speakers were intending to request (95% *CI* for RME scores = [26.9, 28.3], $t = -2.51$, $p = .06$). See Figure 2.

[Figure 2 here]

The remaining pairwise comparisons were not significant (*p*s > .25).

Then, we examined the influence of each EF skill, on its own (in addition to Condition). Beginning with Working Memory, the model including N-Back scores and Condition as fixed effects, along with the interaction between them, did not significantly improve model fit compared to the original, reduced model [$\chi^2(2) = 2.96$, $p = .23$]. Next, a model with Inhibition (measured using the Flanker task) and Condition as fixed effects, along with the interaction between both, showed a non-significant improvement in model fit [$\chi^2(2) = 4.26$, $p = .12$]. The model with Attention Shifting (measured using the WCST) and Condition as fixed effects, along with the interaction between both, showed a similar non-significant improvement of model fit compared to the reduced model [$\chi^2(2) = 4.25$, $p = .12$]. Finally, in order to determine whether a combination of ToM and EF skills accounted for a significant portion of the variance on indirect request interpretation, we created three models, where scores on each EF subskill – and all interactions – were added to the as-yet best fitting model: One with RME scores and Condition as fixed effects, along with the interaction between them. None of the comparisons showed a significant improvement of model fit [N-Back: $\chi^2(2) = 1.11$, $p = .57$; Flanker: $\chi^2(2) = 1.51$, $p = .47$; WCST: $\chi^2(2) = 2.42$, $p = .30$].

Lastly, a post-hoc analysis was performed comparing the response times between groups. Although averages showed slightly longer response times for AUT (493.06ms) compared to NT (392.17ms) participants, this was not significant ($p = .31$).

Discussion

This study is the first to examine how autistic adults interpret hints—indirect requests that do not contain the form and/or semantic components of the underlying imperative. Two research questions were addressed: (1) How do autistic adults compare to NT adults in using context to interpret and utterance's intention as either a request or a comment/question? (2) What cognitive mechanisms correlate with performance on indirect request interpretation, and are these different for participants in each group?

To address Question 1, we assessed autistic and NT adults on their ability to determine whether an utterance is an indirect request or a literal comment/question, based on context. Results indicated that autistic adults perform similarly to NT adults on the indirect request task. While this finding is consistent with previous research showing that hint comprehension is intact for autistic children (Kissine et al., 2015; MacKay and Shaw, 2004; Marocchini et al., 2021), it contradicts to our initial hypothesis. We hypothesized that autistic adults would provide less correct responses on the indirect request task based on the WCC theory as well as our (incorrect) assumption that they would score lower on ToM tasks, which have been shown to correlate with NT adults' indirect request performance on an equivalent task (Trott & Bergen, 2018; 2020). For the current study, participants were required to not only consider the discourse context but also incorporate the speakers' mental states in order to determine intentionality. The fact that autistic participants were successful at this task suggests that they can incorporate both elements into their interpretation of an ambiguous utterance. Consequently, our findings do not support the theory of WCC; autistic adults are just as skilled as NT adults at using discourse context to guide their interpretations of hints.

To address Question 2, we measured ToM using a false belief task and the RME, alongside three EF metrics: working memory, attention shifting, and inhibition. Initially, we formulated two hypotheses related to ToM: one expecting lower ToM scores among the autistic group and the other anticipating that ToM performance would be predictive for how both groups performed on the indirect request task. In contradiction to our first hypothesis, no significant differences in ToM scores were found between autistic and NT participants on either the false belief task or the RME. We suspect that this lack of group differences stems from ToM skills being fully developed by adulthood for autistic participants (see Gernsbacher & Yergeau, 2019 for a review). Despite findings not supporting our first hypothesis, our second hypothesis was partially supported. We found that scores from the RME predicted performance on the indirect request task. Specifically, participants with lower RME scores were more likely to ascribe a literal (i.e., comment/question) intention to utterances produced by unaware speakers versus aware speakers, and they were also less likely to interpret those utterances as requests. This finding supports research from both NT adults (Trott & Bergen, 2018; 2020; van Ackeren et al., 2012) and adults with other disorders affecting pragmatics, such as RHD (Champagne-Lavau & Joanette, 2009), that ToM is involved during hint interpretation.

For EF, we initially hypothesized that autistic participants would score lower than NT participants, and that these scores would be predictive for how individuals performed on the indirect request task. It was found that the groups had comparable inhibition and attention shifting skills, and that the autistic group had significantly greater working memory skills. While this contradicted our initial hypothesis, a few studies have shown autistic college students to score within normal ranges on EF measures (Brady et al., 2016; Toyb et al., 2014). Regarding the predictive effects of EF, we found that none of the three EF metrics predicted a significant portion of variance on the indirect request task. This also contradicted our initial hypothesis, but aligned with the findings reported by Champagne-Lavau and Joanette (2009), who found that EF alone did not predict performance on an indirect request task. In contrast to their findings, however, our study did not observe an enhanced predictive value when combing EF and ToM scores.

Linguistic vs. Social Pragmatics

The fact that indirect request comprehension is intact in autistic populations lies in stark contrast to the consistent evidence that autistic individuals show differences in their understanding of other types of non-literal language, such as irony (e.g., Deliens et al., 2018; Happé, 1993). Andrés-Roqueta and Katsos (2017; 2020) have suggested a dichotomy between linguistic pragmatics and social pragmatics to provide insight into why autistic individuals are proficient in certain pragmatic tasks and not others. In this framework, linguistic pragmatics encompasses pragmatic tasks that only require linguistic skills and basic knowledge of pragmatic norms for successful comprehension (e.g., scalar implicatures). Conversely, social pragmatics encompasses tasks that demand not only linguistic and pragmatic understanding, but also the engagement of ToM (e.g., irony). Researchers have suggested that the intact comprehension of indirect requests, in contrast to poorer performance on other forms of non-literal language, like irony, in autistic populations supports the existence of these two types of pragmatics (Andrés-Roqueta & Katsos, 2020; Deliens et al., 2018; Marocchini et al., 2021). For example, Deliens and colleagues (2018) argued that the embedded request forms utilized in their study were an example of linguistic pragmatics, given that listeners can rely on the conventionalized structural frame (e.g., “Can you...?”) to interpret speaker meaning. While embedded imperatives fall within the category of linguistic pragmatics, this may not be the case for hints. Marochinni and colleagues (2021) argued that since ToM was not involved in autistic children’s interpretations of hints, these forms could also be categorized as linguistic pragmatics. However, we found that ToM, as measured by the RME, *was* predictive for the adults in this study interpret hints. As such, it appears that for adults, hints should be classified as social pragmatics.

Complicating this interpretation, however, is the fact that the notion of “ToM” itself involves numerous, multifaceted subcomponents of human cognition, which may or may not actually assemble into one discrete process that can be measured by one overall ToM test (Quesque & Rossetti, 2020). Further, tests that purportedly measure ToM often rely on unrelated areas of cognition and language. Beginning with false belief tasks, evidence suggests that verbal abilities strongly correlate with performance, and that as autistic individuals reach adolescence, they tend to perform similarly to the NT peers on such tasks (Happé, 1995; Scheeren et al., 2013). In support of this, our participants showed close-to-ceiling-level performance on the false belief task, with 20 out of 25 participants in the AUT, and 22 out of 23 participants in the NT group, earning perfect scores on the task. This correlation between language abilities and such tasks motivated our inclusion of the RME, a ToM task that should avoid correlations with reading comprehension. However, the RME is not without its problems. Several studies have indicated that performance on the RME is more related to factors such as intelligence, vocabulary, and emotional recognition, rather than mentalizing (Baker et al., 2014; Oakley et al., 2016; Olderbak et al., 2015). In fact, some authors purport that tests requiring participants to identify emotional expressions form pictures do not measure ToM at all, arguing that true ToM tasks should not only test whether participants can determine someone's mental state, but also distinguish their own mental state from that person's (Oakley et al., 2016; Quesque & Rossetti, 2020).

Although the RME may assess emotional recognition, rather than true mentalizing, the results from our study align with findings from other studies demonstrating that various ToM measures predict comprehension of hints in both clinical (Champagne-Lavau & Joanette, 2009) and non-clinical populations (Trott & Bergen, 2018; 2020). Champagne-Lavau and Joanette (2009) assessed ToM in RHD patients using 20 false belief stories, while Trott and Bergen (2018; 2020) assessed ToM in NT adults used the SST. Notably, both of these tasks rely on reading skills, unlike the RME, yet they yielded similar results. Additionally, van Ackeren and colleagues (2012) found brain regions associated with mentalizing were activated during indirect request interpretation in NT adults. Therefore, it would seem that ToM is used by adults when determining if an utterance is intended to be a request.

Under the assumption that ToM is used by adults to interpret hints, the theory of linguistic versus social pragmatics is not sufficient in explaining why autistic adults have success with indirect requests, but not other types of non-literal language that require ToM, such as irony. We contend that the difference between indirect requests and irony lies not in the demand for ToM, as others have suggested (Andrés-Roqueta & Katsos, 2020; Deliens et al., 2018; Marocchini et al., 2021), but in the type of mental state decoding required for each. In our indirect request task, participants needed two pieces of information to be successful: (1)

familiarity with the pragmatic convention of using comments and questions as indirect requests, and (2) an understanding of the speaker's level of awareness (e.g., *S is unaware that the heater is broken; therefore, S's utterance is probably not a comment, but a request to turn on the heater*). As such, the only mental state the listener needs to decode is speaker awareness. We argue that this type of mental state decoding is more straightforward than the mental state decoding needed to interpret irony. Interpreting irony requires the listener to attribute a mental state to the speaker that is often the *opposite* of what is said, and usually involves decoding para- and extra-linguistic cues, like intonation and facial expressions, respectively (Attardo et al., 2003). Hence, irony demands a more multi-layered analysis in contrast to the relatively simpler decoding involved in indirect request comprehension.

Conclusion

This study investigated how autistic college students comprehend hints, which are indirect requests that do not contain the form and/or semantic components of the underlying imperative. To our surprise, results revealed that hint comprehension is similar for autistic and NT college students, challenging our hypothesis that autistic adults would perform less accurately due to assumed lower ToM abilities. While no significant differences in ToM scores were found between the two groups, perhaps because the autistic group's ToM skills are fully developed by adulthood (see Gernsbacher & Yergeau, 2019 for a review), the study supported the notion that mentalizing predicts the ability to utilize context to determine if an utterance is intended as a hint. These results have implications for the linguistic- versus social-pragmatics framework (Andrés-Roqueta and Katsos, 2017; 2020), since hint interpretation should arguably be categorized as social-pragmatics, as it involves both linguistic knowledge and mentalizing, yet autistic adults seem in to interpret hints well. Based on our findings and those from previous work, we suggest that successful hint comprehension differs from the understanding of other types of non-literal language, like irony. It seems that the simple, binary split between linguistic and social pragmatics is insufficient for predicting autistic individuals' comprehension patterns; a more comprehensive model may need to accommodate how the interface between (social) pragmatics and para-/extra-linguistic information affects interpretation.

Limitations and Future Research

It should be noted that successful performance on our indirect request task may not necessarily translate to real-life conversations. In the current experiment, there was no effect of EF on individuals' performances on the indirect request task. It is possible that our task may not have fully engaged EF skills. The untimed nature of the task and its completion over the internet in a likely non-distracting environment, may have minimized the impact of EF. In real-life conversations that require quick processing and the inhibition of distracting stimuli, EF may have a more significant effect on indirect request interpretation. Additionally, performance on this task involved which paraphrase participants ultimately chose, rather than online processing. Future research incorporating open answer questions, time-constraints and distracting stimuli may provide findings close to real-life scenarios. Furthermore, it is crucial to consider the heterogeneity within the autistic population, given that we only tested autistic college students. Conducting future studies with autistic adults at different educational levels would provide a more comprehensive understanding of indirect request comprehension in this population.

Finally, we recommend further research on how autistic children interpret hints, specifically assessing how children utilize context to determine whether or not an utterance is intended to be an indirect request. Given that our findings suggest that (at least some) ToM subskills are involved in indirect request interpretation for all participants, and because previous research fairly consistently finds differences in scores on ToM tasks for autistic children (e.g., Baron-Cohen, 2000), it is possible that autistic children would perform differently on this task than NT children and/or that cognitive mechanisms aside from ToM (e.g., EF) would contribute to their understanding.

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Appendix A

Speaker Aware

You and your friend Jonathan are taking a road trip. You began in California, and are now passing through Michigan. It's almost winter, so it's very cold outside - especially for Southern California dwellers like you and Jonathan. You see that you're almost out of gas, so you stop at a gas station in a small town.

You fill up the tank, and then the two of you go inside the gas station to buy some water and snacks. When you return to the car and start up the engine, you and Jonathan notice with some dismay a blinking light, which indicates that the car's heating system is broken. You both bundle up.

As you leave the station, Jonathan shivers in his seat. He turns to you and says, "Man, it's really cold in here."

Speaker Unaware

You and your friend Jonathan are taking a road trip. You began in California, and are now passing through Michigan. It's almost winter, so it's very cold outside - especially for Southern California dwellers like you and Jonathan. You see that you're almost out of gas, so you stop at a gas station in a small town.

While you fill up the tank, Jonathan goes inside to buy some water and snacks. As you're checking the meter, you notice with some dismay a blinking light, which indicates that the car's heating system is broken. You finish filling up the gas and wait for Jonathan.

Jonathan returns with some snacks, and you both set off. As you leave the station, he shivers in his seat. He turns to you and says, "Man, it's really cold in here."

Paraphrase Options:

Could you turn on the heater?
I'm really cold; it's too bad the heater is broken.

Appendix B

Question 1

Anthony has just returned home from the gym. He puts his cell phone and wireless headphones on the kitchen table and goes upstairs to shower. While Anthony is showering, his roommate, Sean, goes into the kitchen to make some lunch. While Sean is making his lunch, he hears some faint music coming from Anthony's headphones. Apparently, Anthony had forgotten to turn off his music after returning home from the gym. Sean can't turn off the music because he doesn't know Anthony's phone's passcode, and even after trying to turn down the phone's volume, he can still hear the music. Sean starts to get annoyed by the music, so he puts the phone and headphones in Anthony's gym bag.

After Anthony is showered and dressed, he remembers he needs to text a friend.

Where does he look for his phone?

a. Table
b. Gym bag
c. Shelf
d. Chair

Question 2

Rachel has just finished baking cookies for her and her kids. She always makes two kinds of cookies: Peanut butter cookies for herself and chocolate chip cookies for her kids, who both have a mild peanut allergy. Because of her kids' allergies, it is important that she keeps her cookies separate from theirs and that it's clear to everyone which cookies are which. To do that, she always puts the chocolate chip cookies in a blue jar on the dining-room table and the peanut butter cookies in a red jar on the kitchen counter. After she puts the cookies in their respective places, she goes out to run some errands and to pick up her kids from school. While she's away, a cleaning company is scheduled to come clean her house. The cleaners move both cookie jars so they can clean the table and the counter, and when they put the jars back, they mix up which one goes where: They put the red jar on the table and the blue jar on the counter.

When Rachel comes in with her kids after school, she tells them there is a jar of fresh-baked cookies on the table for them.

Which jar does Rachel think is on the table?

a. Red jar of peanut butter cookies
b. Blue jar of chocolate chip cookies
c. Red jar of chocolate chip cookies
d. Blue jar of peanut butter cookies

Question 3

Henry’s birthday is this weekend. On Wednesday, he sees an Instagram post announcing that his favorite band has a last-minute performance planned at a nearby venue on Friday. He forwards the post to his girlfriend, Jada, and comments that going to see the band would be a perfect birthday celebration. Later that day, Jada tells Henry that she tried to get tickets, but they were already sold out. She suggests going to the movies instead. On Friday morning while Jada is taking a shower, an event alarm goes off on her phone. Henry glances at it and sees that it’s a reminder for the concert that evening. He realizes that Jada was able to get tickets to the concert, after all. Henry does not tell Jada about his discovery.

Later that evening, Jada tells Henry it’s time to go to the movies. She says that she’ll drive them to the movie theater.

Where does Henry think he’s going?

a. Restaurant
b. Museum
c. Movies
d. Concert

Where does **Jada** think Henry thinks he’s going?

a. Restaurant
b. Museum
c. Movies
d. Concert

Table 1

Participant Characteristics

	AUT (n = 25)	NT (n = 23)	t	p
Age	20.0 (2.0)	19.8 (1.8)	-.32	.75
Autism Quotient	32.20 (4.45)	16.52 (5.07)	-11.34	<.001**
SAAB	14f:11m	13f:10m	-.04	.97

Note. SAAB = sex assigned at birth.

Table 2

Proportion of Responses by Group per Condition

	AUT		NT	
Condition	Literal	Request	Literal	Request
Speaker Aware	84%	16%	89.3%	10.7%
Speaker Unaware	14%	86%	14.2%	85.8%

Table 3

Mean Score (SD) / Highest Possible Score for Each Group in the Tasks Assessing ToM and EF

	AUT	NT	*t*	*p*
False Belief	3.80 (.41) / 4	3.96 (.21) / 4	1.65	.11
RME	26.36 (3.60) / 36	26.91 (3.77) / 36	0.52	.61
Flanker	29.64 (3.40) / 30	29.22 (4.95) / 30	-0.35	.73
WCST	45.44 (6.36) / 60	46.78 (5.54) / 60	0.78	.44
N-Back	25.16 (3.57) / 30	22.87 (4.26) / 30	-2.03	.05*

Table 4

Model of Best Fit

	Parameter estimates		Wald's test		
Predictors (fixed effects)	β	*SE*	*z*	*p* (β = 0)	Odds Ratio
Condition	-2.62	2.21	-1.18	.24	0.073
RME	-0.10	0.06	-1.65	.10	0.905
Condition: RME	0.25	0.09	2.87	<.001**	1.279