COMMENTARY

Revisiting the simplification of adult language input in the context of naturalistic developmental behavioral interventions: A commentary

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Abstract
Naturalistic developmental behavioral interventions (NDBI) are an evidence-based class of early interventions for improving language and social communication skills in autistic children. However, relatively little is known about how individual elements of NDBI support child development. This commentary focuses on one common element across NDBI models: the simplification of adult language input. Advances in developmental science focusing on the length and complexity of adult spoken utterances suggests that natural, grammatical utterances facilitate comprehension and expressive language development in autistic and nonautistic children. Yet, NDBI tend to recommend shorter and simpler adult utterances. We close by describing directions for future research which would inform recommendations around adult language input in NDBI to optimally support child language and communication development.

KEYWORDS
autism spectrum disorder, children, communication, early intervention, language, modeling, naturalistic developmental behavioral interventions

In a ground-breaking 2015 article, Schreibman and colleagues described a group of intervention approaches for young autistic children known as naturalistic developmental behavioral interventions (NDBI; Bruinsma et al., 2020). Though specific NDBI approaches differ in some respects, they are united by their common theoretical grounding in applied behavior analysis and developmental science. A growing body of research points to positive effects of NDBI (Sandbank et al., 2020; Tiede & Walton, 2019), including improvements in children's cognitive, language, communication, and motor skills, and decreases in maladaptive behaviors (e.g., aggression, self-injury, tantrums; Fulton et al., 2014) and symptom severity—as well as evidence that intervention gains can be maintained over time (Estes et al., 2015). Yet, we know very little about the individual components that comprise these complex interventions (Bruinsma et al., 2020; Kaiser & Hampton, 2017).

Understanding which components of NDBI affect child outcomes (i.e. "active ingredients"; Gulsrud et al., 2016) is important for maximizing the efficiency and effectiveness of NDBI (Bruinsma et al., 2020; Schreibman et al., 2015; Tiede & Walton, 2019; Vivanti et al., 2018). Similarly, it is important to improve our ability to individualize NDBI by determining "…under what circumstances, for whom, at what level, and if a particular element is important to include in the package" (Bruinsma et al., 2020, p. 409). After all, children vary widely in how well they respond to intervention (Vivanti et al., 2014), and immediate intervention gains do not always last (Hampton et al., 2017).

In this commentary, we consider one intervention component and potential active ingredient of NDBI: adult language input.[1] In particular, we focus on the common recommendation that adults simplify their spoken utterances by matching or slightly exceeding the

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[1]The issue of adult language input is also relevant to other types of autism interventions, including traditional ABA approaches. We focus on NDBI as a first step because they are one of the largest classes of interventions for autistic children that explicitly incorporate developmental principles.

child's spoken language level.[2] Though it may be intuitive and appropriate for adults to simplify their utterances to some extent (e.g., relative to adult conversation), recent developmental research points to the importance of ree-valuating how adults simplify their spoken utterances and how they individualize the simplified language input they provide when delivering NDBI. Here, we examine the recommendations and rationale for providing exten-sively simplified language input to young autistic children within NDBI. Highlighting recent findings from develop-mental language research, we propose that the extensive and consistent simplification of adult utterances often recommended within NDBI is not well supported by existing evidence. We close by describing future direc-tions for developmental and clinical research.

PROVIDING SIMPLIFIED ADULT LANGUAGE INPUT WITHIN NDBI

Within NDBI, adults are commonly advised to simplify their utterances when modeling appropriate language and responding verbally to children's attempts to com-municate (Frost et al., 2020). In the context of NDBI, language modeling involves talking about the child's focus of attention (what the child is looking at and/or doing) during play or other daily routines (Bruinsma et al., 2020; Frost et al., 2020). Responding verbally to child communication (e.g., expanding) involves building on children's communication attempts within social inter-actions. We consider these strategies concurrently because both provide language input and do not require a verbal response from the child (as opposed to questions or prompts for verbal imitation, which we do not focus on here). Modeling and responding are grounded in social interactionist theories, which posit that language acquisition is driven by social interaction between the child and linguistically knowledgeable adults (Bottema-Beutel & Kim, 2021; Bruinsma et al., 2020; Schreibman et al., 2015). The transactional model also supports use of these strategies by emphasizing the importance of bidi-rectional influences between children and adults during social interactions (Camarata & Yoder, 2002; Sameroff & Fiese, 2000). For example, a child's spoken

utterance provides the foundation on which the adult builds their subsequent verbal response (e.g., when an adult expands the child's utterance).

When modeling and responding within NDBI, adults are advised to shorten their utterances to match or slightly exceed the length of the child's spoken utterances (i.e., "one-word-up"; Bruinsma et al., 2020; Frost et al., 2020; Kaiser et al., 2000; Rogers et al., 2012; see Table 1). Because many young autistic children produce limited or no spoken language (Charman et al., 2003; Ellis Weismer & Kover, 2015; Luyster et al., 2007), adult input within NDBI often consists of single words and simple phrases. NDBI manuals indicate that adults should model primarily single words for children who are not yet talking, and single words or 2-word phrases for children who say single words themselves. They are advised to increase the complexity of their speech as a child's spoken language develops, modeling simple sen-tences (e.g., *The baby is sleepy*) after children can produce spontaneous 2- to 3-word phrases, and more complex sentences (e.g., *We're pushing our cars very fast*) after children can produce simple sentences. In line with infor-mation processing theory, the rationale is that extremely short utterances reduce processing burden and increase the salience of key words, which should make it easier for young autistic children to understand and learn from spo-ken language (Crandall et al., 2019; Wolfe & Heilmann, 2010). In this way, NDBI purposefully create a language environment for autistic children that differs from what they otherwise would have been exposed to.[3]

Recommending that adults produce very short phrases can sometimes yield grammatically incomplete utterances known as telegraphic input (Bredin-Oja & Fey, 2014; van Kleeck et al., 2010; Venker, Yasick, & McDaniel, 2019). Telegraphic input refers to multiword adult utterances that include content words (e.g., nouns, verbs, adjectives) but remove function words and gram-matical markings (van Kleeck et al., 2010).[4] Telegraphic adult utterances provided as examples within NDBI manuals and other intervention resources include: *More ball; Put on; Cut dough; Top on; Blow bubble; Here's dia-per; Cow, put in; Give to Papa; Yes, Ethan wants swing!; Apple on plate; Here comes ball!; Blue socks on feet; Red car go; Want carrot?; Can you give Daddy?; Ball here* (Bruinsma et al., 2020; Ingersoll & Dvortcsak, 2019; Rogers et al., 2012; Wetherby, 2021). As these examples illustrate, telegraphic phrases are artificially truncated in ungrammatical ways that rarely occur in adult conversa-tion or in child-directed speech to nonautistic children

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[2]In line with developmental theory, one characteristic of appropriate modeling and responding is following into the child's focus of attention (one aspect of a responsive interaction style; McDuffie & Yoder, 2010; Rowe & Snow, 2020). Basing adult input on the child's attentional focus creates a temporal and conceptual link between what children hear and what they see at a given moment, which is thought to support the development of receptive and expressive language skills (Tamis-LeMonda et al., 2014; Venker et al., 2018). Though additional experimental studies are needed to fully understand this relationship, parent verbal responsiveness is consistently associated with language and communication skills in young autistic children (or children with an increased likelihood of being autistic; Bottema-Beutel & Kim, 2021; Edmunds et al., 2019). Given this strong theoretical and empirical support, it is not surprising that following into the child's focus of attention is a well-accepted and commonly used aspect of adult language input across NDBI. We do not focus further on this well-established practice.

[3]Though NDBI have been implemented in numerous languages (e.g., German, Italian; Colombi et al., 2018; Holzinger et al., 2019), they were originally developed in English. For this reason, we provide examples of simplified speech in English in this commentary. Future research is needed to better understand what linguistic simplification and "natural" speech look like when NDBI are implemented in a variety of different languages and dialects.

[4]In this commentary, we do not consider pragmatically logical, single-word utterances to be telegraphic because they do not inherently violate grammatical rules of English.

TABLE 1 How NDBI describe simplified adult language input

Intervention	Relevant excerpts
NDBI Bruinsma et al., 2020	"Most NDBI suggest using simple words or very short phrases when narrating and expanding as the child's language develops…" (p. 242). "Rogers and Dawson (2010) suggested the one-up rule, in which adults speak to children in phrases or sentences that contain the same number of words the child's spontaneous sentences contain plus one additional word" (p. 243).
ESDM Rogers et al., 2012	"…for a child with [autism spectrum disorder], it's particularly important to keep your language simple—almost as simple as your child's…" (p. 122). "For children who are not talking yet, you want to keep your sentences really short and to the point. Limit your language to simple words and short phrases to capture the key nouns and actions of your child's movements." (p. 295). "You want your language to be just a little more complex than your child's. This is what we call the one-up rule: make your sentence one word longer than your child's. If your child doesn't talk yet, or if your child is just beginning to use words, then these one- to three-word phrases are just about right" (p. 296).
Project ImPACT Ingersoll & Dvortcsak, 2019	"Use simple language. Some children have difficulty understanding speech or gestures when we use too many words. By changing the way you speak, you can help your child understand what you say. Model new communication skills that are slightly more complex than the skills your child uses on his own. For example, if he communicates by using single words, model two-word phrases" (p. 43).
EMT Kaiser & Hampton, 2017	"…target-level language…encourages parents to use language that is at the child's target-level MLU for half of all communication and slightly longer than the child's MLU (+1.5) for the remaining communication…For example, if the child vocalizes while rolling out playdough, the parent might respond by saying 'Roll,' or 'Roll the playdough' to give a clear model of the target language for the child" (p. 103).
JASPER Kasari et al., 2021	"The typical pace, vocabulary, and language level of adults is often too complex for the child to produce. Instead of talking as you normally would, stay within one word of the child's mean length of utterance (MLU)" (p. 101). "When you imitate and expand, adapt to the child's developmental level. If the child speaks in one-word utterances, your responses will be two words…" (p. 207).

Abbreviations: EMT, enhanced milieu teaching; ESDM, early start Denver model; ImPACT, improving parents as communication teachers; JASPER, joint attention, symbolic play, engagement, and regulation; NDBI, naturalistic developmental behavioral interventions.

(Chafetz et al., 1992; Soderstrom, 2007). As a result of their artificial simplification, the interactional implications of telegraphic utterances may be unclear. In contrast, nontelegraphic phrases are those that occur naturally in informal conversation (e.g., *Your turn; Go fast!; She did; My puppy*), do not violate grammatical rules, and are fully meaningful within broader conversational context.

Although historically common across a range of autism interventions (Lovaas, 2003; Sussman, 1999; van Kleeck et al., 2010), telegraphic input has come into question in recent years because it provides an unnatural and inaccurate representation of spoken language that may not be beneficial for autistic children (Bang et al., 2020; Fusaroli et al., 2019; Sandbank & Yoder, 2016; van Kleeck et al., 2010; Venker et al., 2015; Vivanti & Messinger, 2021). In line with these concerns, a growing number of NDBI have begun to advocate for natural adult language input that is grammatical, rather than telegraphic (Bruinsma et al., 2020; Ingersoll & Dvortcsak, 2019; Kaiser & Hampton, 2017). For example, enhanced milieu teaching "…has evolved away from modeling less natural, grammatically incomplete forms. Thus, although a target phrase may include only two words, the parent or clinician is encouraged to retain all articles and appropriate grammatical markers so that the target represents a portion of a grammatically correct phrase or sentence" (e.g., *Roll the ball* rather than *Roll ball, The ball rolls* rather than *Ball roll*; Kaiser &

Hampton, 2017; pp. 103–104). From a transactional perspective, grammatical adult input would be particularly important in the case of expansions and recasts, wherein an adult builds on and/or corrects a child's verbal production (Bruinsma et al., 2020).

Though it may be logical for adults to simplify their language to some degree, there is no empirical evidence that extensively simplifying adult utterances (e.g., "one word up") is beneficial. In fact, there is growing concern that the language input provided to autistic children may in some cases not be the natural, grammatical input so often promoted for other children (Bang et al., 2020; Bottema-Beutel & Kim, 2021; Choi et al., 2020; Fusaroli et al., 2019; Kaiser & Hampton, 2017; Sandbank & Yoder, 2016; Venker et al., 2015, 2020). Below, we highlight recent findings from developmental research and discuss implications for adult language input within NDBI.

Natural, grammatical language input supports language processing

Part of the rationale for providing simplified language input is to make it easier for children to understand spoken language. One body of relevant work comes from experimental studies examining the speed and accuracy of children's spoken language processing. Processing studies commonly use screen-based, "looking-while-

listening" tasks (Fernald et al., 1998, 2008) that present two images (e.g., ball, spoon), along with spoken language describing one of the images (e.g., *Can you see the ball?*). Children's eye movements indicate—within a fraction of a second—how quickly and accurately they comprehend the target noun, which provides insight into the real-time effects of different utterance types. Thus, processing studies are well-suited to evaluate whether shortening adult utterances makes it easier for children to understand spoken language. Although processing studies examine comprehension in a controlled, experimental setting, their findings have implications for children's understanding of spoken language during everyday social interactions—as well as their (and their communication partner's) subsequent response.

One potentially surprising finding is that shorter utterances are not always easier to understand. Fernald and Hurtado (2006) found that typically developing 18-month-old infants processed object nouns more quickly in a familiar carrier phrase (e.g., *Look at the doggie!*) than in isolation (e.g., *Doggie!*), suggesting that carrier phrases support efficient language processing. Kedar et al. (2006, 2017) presented typically developing infants (12–24 months) with simple sentences that were grammatical (e.g., *Can you see the cup?*) or telegraphic (e.g., *Can you see _ cup?*). Grammatical utterances facilitated processing, even though they were longer and more complex than telegraphic utterances. Notably, 12-month-old infants showed an advantage for grammatical utterances, even though determiners (e.g., *the*) had not yet appeared in their productive speech.

Furthermore, children process spoken language incrementally, making sense of linguistic information in the speech stream as it unfolds. They can use unfolding linguistic information to anticipate upcoming words, which facilitates efficient language processing (Bavin, Prendergast, et al., 2016; Fernald et al., 2010; Lew-Williams & Fernald, 2007). For example, both typically developing and autistic children can use semantically informative verbs (e.g., *Eat the cookie* rather than *Find the cookie*) to anticipate upcoming nouns, giving them a head start in language processing (Bavin, Kidd, et al., 2016; Borovsky et al., 2012; Brock et al., 2008; Fernald et al., 2008; Hahn et al., 2015; Venker, Edwards, et al., 2019). If a spoken utterance does not contain a semantically informative verb, children must wait to process an object noun until it is presented. Somewhat paradoxically, these findings indicate that—at least in some cases—longer utterances allow for more efficient language processing than shorter utterances.

Longer adult utterances are linked with stronger child language outcomes

Providing simplified language input within NDBI is meant to support not only understanding in the moment,

but also language development over time. Yet, observational studies examining the relationship between adult language input and child language outcomes suggest that longer adult utterances are associated with better child language outcomes for both autistic and typically developing children (Bang et al., 2020; Feldman, 2019; Huttenlocher et al., 2010; Rowe & Snow, 2020; Sandbank & Yoder, 2016; Swanson et al., 2019). Most of these studies have focused on expressive language outcomes (but see Choi et al., 2020), but findings are usually interpreted as having implications for child language development, broadly construed. Because these studies adopt a correlational design, there is a possibility of third variable explanations; we describe experimental studies that complement this observational approach in Future Directions.

In typical development, longer adult mean length of utterance (MLU) is consistently linked with stronger child spoken language outcomes (Feldman, 2019; Hoff & Naigles, 2002; Huttenlocher et al., 2010; Rowe, 2012; Rowe & Snow, 2020). MLU represents the average number of words or morphemes in adult spoken utterances and is commonly considered to represent utterance length and grammatical complexity (Hoff, 2003; Sandbank & Yoder, 2016). For example, Hoff (2003) identified a positive correlation between parent MLU and later productive vocabulary in infants with typical development (16–31 months), even after controlling for children's baseline vocabulary skills. Huttenlocher et al. (2002) found that preschoolers whose teachers provided more syntactically complex input in the classroom showed greater syntactic growth 1 year later, even though teacher input was not significantly correlated with children's language skills at the beginning of the school year. Though correlational, these findings have consistently been interpreted as suggesting that natural, grammatically well-formed language input is beneficial for child language development (Anderson et al., 2021).

As in typical development, numerous studies have shown that longer adult MLU is associated with stronger language outcomes in samples of autistic children (or those with an increased likelihood of being autistic), even after controlling for baseline child language skills and other aspects of adult input (Bang et al., 2020; Bang & Nadig, 2015; Choi et al., 2020; Fusaroli et al., 2019; Sandbank & Yoder, 2016; Swanson et al., 2019). In fact, a recent meta-analysis found that the association between parent MLU and child expressive language outcomes was significantly *stronger* for autistic children than for children with other developmental disabilities, suggesting that adult MLU may play particularly important role for this population (Sandbank & Yoder, 2016; also see Bang et al., 2020). Notably, the autistic children in these studies spanned a wide range of ages (9 months to 7 years old) and language abilities, and many children demonstrated considerable language delays. Because this body of work has focused primarily

on children's spoken language outcomes, it is not yet known the extent to which these findings may generalize to the population of autistic children who are not talking.

The similarity in the relationship between adult MLU and child language outcomes across typical development and autism aligns with the view that language development in autistic children—though often delayed—may in some ways be qualitatively similar to typical language development (Arunachalam & Luyster, 2016; Ellis Weismer et al., 2011). Thus, the characteristics of adult language input that are beneficial for children with typical development at a given language level (Rowe & Snow, 2020) may also be beneficial for autistic children. However, it is important for future studies to investigate how qualitatively distinct features of language development in autism (e.g., echolalia) interact with the complexity of adult input.

Experimental research points to one potential mechanism for how longer and more complex utterances facilitate language development. Research on word learning has shown that linguistic cues in grammatical language input help children discover the meanings of new words—a process known as syntactic bootstrapping (Gleitman, 1990). For example, autistic and nonautistic children alike can use the syntactic structure of spoken utterances (e.g., *The duck is gorping the bunny*) to infer that a novel verb (i.e., *gorping*) refers to a causative action, rather than a noncausative action (Arunachalam & Waxman, 2010; Naigles, 1990; Naigles et al., 2011; Shulman & Guberman, 2007). Similarly, morphological cues (e.g., plural *-s*) can help children determine the meaning of novel words (Jolly & Plunkett, 2008; Paquette-Smith & Johnson, 2016). However, telegraphic and single-word utterances omit morphological and syntactic cues, creating sparse linguistic input during a developmental period that is foundational for early word learning. Indeed, Venker et al. (2015) found that parents who produced higher proportions of telegraphic utterances had autistic children with poorer language outcomes 1 year later. In the absence of syntactic and morphological cues (e.g., in single-word or telegraphic utterances), children may not have the information needed to determine the meaning of new words.

FUTURE DIRECTIONS FOR DEVELOPMENTAL AND CLINICAL RESEARCH

Current developmental language research supports the use of natural, grammatical language input for autistic and nonautistic children alike. Accordingly, a growing number of clinical researchers have emphasized the benefits of providing natural, grammatical language input to autistic children (Bang et al., 2020; Choi et al., 2020; Fusaroli et al., 2019; Sandbank & Yoder, 2016; Venker

et al., 2020) and have recommended against providing input that is artificially simplified, including telegraphic models (Bang et al., 2020; Bang & Nadig, 2015; Choi et al., 2020; Sandbank & Yoder, 2016; Venker et al., 2015). Though many of these recommendations have focused on parents and caregivers, it has also been suggested that extensively simplified input (e.g., telegraphic utterances, very short MLU) be avoided in intervention contexts (Bang & Nadig, 2015; Sandbank & Yoder, 2016). However, there remains a great deal we do not understand about whether, how, and to what extent adult language input should be simplified in intervention contexts to support autistic children's language development, as well as the potential mechanisms through which simple language might support child language development.

Here, we identify several key questions that we believe should be answered to inform evidence-based practices around adult language input in NDBI. We highlight several distinct but complementary research methodologies and study designs that are well-suited to advancing our understanding of this topic. This proposed line of work represents a shift toward identifying active ingredients of interventions, mechanisms of change, potential moderators of intervention effects, and stakeholder views. NDBI have most often been studied as a whole package, without consideration of individual elements of these complex interventions (for exceptions, see Gulsrud et al., 2016; Ingersoll et al., 2012; Zitter et al., 2021). Building on previous literature that confirms a causal link between intervention implementation and child outcomes (Pickles et al., 2015; Yoder et al., 2021), isolating active ingredients of NDBI requires assessing individual intervention elements and linking them statistically with their intended outcomes and mechanisms of change (e.g., tests of mediation). In addition, it is critical to examine potential child-level moderators to help us understand how adult language models should be individualized to best support children's communication growth at different stages of development.

1. How does the complexity of adult language input affect children's language processing?

It is commonly proposed that providing simplified language input should help autistic children process spoken language, but extant research has not fully tested this assumption experimentally. Conducting such studies is critical for ensuring the use of individualized, evidence-based practices in autism intervention. From a cognitive processing perspective, looking-while-listening tasks offer one way to examine whether different styles of adult language input support language processing for children at different expressive language levels—including autistic children who do not speak (Fernald et al., 2008; Marchman et al., 2018; Marchman & Fernald, 2008; Venker et al., 2013). In measuring moment-by-moment attention

to target stimuli, looking-while-listening studies can shed light on the mechanisms that underlie the relationship between adult input and child language outcomes (Weisleder & Fernald, 2013). For example, by systematically varying the grammatical complexity of spoken utterances (e.g., highly simplified, single-word utterances [*ball*] vs. simple, grammatical sentences [*the ball is bouncing*]), it would be possible to examine whether one style of adult language input offers any advantages for the accuracy or efficiency of children's language processing. This line of work could also be expanded to determine how the prosody of adult utterances affects children's language processing—an important question to consider with respect to the vast literature on child-directed speech (Bedore & Leonard, 1995; Soderstrom, 2007).

Furthermore, these methods are sensitive to individual differences (Bavin et al., 2014; Venker et al., 2013), and thus are well-positioned to assess child-level moderators—how children's language and cognitive skills may change the relationship between simplified utterances and child language processing. Although the existing literature suggests that language complexity can facilitate language growth, optimal adult language models may shift as children make developmental gains in expressive and receptive language (Bang & Nadig, 2015; Rowe & Snow, 2020). When to shift—and how much—remains an open question that future studies must address. This research will help identify the optimal balance between simplicity and complexity for facilitating language development, especially given the vast variability in language skills among autistic children (Ellis Weismer & Kover, 2015; Kjelgaard & Tager-Flusberg, 2001).

2. How does the complexity of adult language input affect children's communication behaviors, social engagement, and interaction quality during adult-child interactions?

Different styles of adult language input may affect children's language development through mechanisms other than language processing. Interactionist theories of language development emphasize how caregiver talk may create opportunities for children to communicate and support their engagement in a shared social activity. Consistent with this perspective, highly simplified adult utterances might benefit children's language development by supporting more frequent spontaneous (i.e., unprompted) verbal imitation or a longer time spent in a state of joint engagement, compared with more complex adult utterances. This line of research could also be broadened to investigate other components of adult language input, such as how talkative adults are and how much wait time they provide between utterances.

Single-case experimental designs are one way to examine how different styles of adult language input might affect child communication and joint engagement during NDBI sessions (Kratochwill et al., 2010). Dependent variables that are expected to change relatively rapidly upon introduction of the intervention and/or are likely to reverse when intervention is withdrawn (i.e., are context-dependent) are ideal candidates for such a design (Yoder et al., 2018). To examine the hypothesis above, an alternating treatments design in which each participant experiences different styles of adult language input either within or across several sessions would allow for the direct comparison of an NDBI with highly simplified adult language input to an NDBI where the adult speaks primarily in simple, grammatical sentences (Bredin-Oja & Fey, 2014). Through frequent, repeated measurement of joint engagement as well as the rate and accuracy of child imitative and nonimitative utterances, researchers could examine whether one style of adult language input is associated with higher rates of joint engagement, imitative utterances, and spontaneous communication during NDBI sessions.

Sequential analysis is an observational method which may also prove useful in examining temporal associations between adult language input and moment-to-moment changes in child behavior (Bakeman & Quera, 2011; Yoder et al., 2018). This approach has several benefits, including the ability to use larger samples, supporting generalization of results to populations consistent with the sample, and the ability to consider how multiple facets of adult language input might be associated with child communication, social engagement, or other behavior. Conversely, these methods could also be used to examine ways in which adult language input might shift in response to child cues and communication styles.

3. How does the complexity of adult language input within NDBI affect children's language and communication skills over time?

Armed with preliminary data on mechanisms of change in intervention, researchers can use group designs (e.g., comparative randomized controlled trials) to test hypotheses about how adult language input within an NDBI context affects child language and social communication outcomes over time. In such a design, two (or more) groups would receive an NDBI that is identical in all respects except for the style of adult language modeling. This approach would extend recent findings by Zitter et al. (2021), who used a correlational approach to examine the relationship between natural variation in fidelity to ESDM components and child learning response. While they found that "appropriateness of adult language" was associated with children's demonstration of specific skills during sessions, future studies should examine whether specific aspects of adult input (e.g., complexity) predict language gains over time.

With other aspects of the intervention controlled for experimentally, researchers can isolate specific causal effects of adult language input on child receptive and

expressive language growth over time (van Kleeck et al., 2010). While a standard RCT is typically conducted as a superiority trial, the comparative RCT as described here may be more appropriately conceptualized as an equivalence trial testing whether two interventions are not appreciably different (Schumi & Wittes, 2011). If an equivalence trial indicates no clinically meaningful difference between styles of adult language input, this would suggest that extensive simplification of adult language input may not be the best use of intervention and training resources. Rather, general recommendations around providing natural language input (without artificial, ungrammatical simplification) may be most beneficial.

4. How are recommendations surrounding adult language input understood by NDBI stakeholders?

Characterizing perspectives of key stakeholders in NDBI, including autistic people, caregivers, and clinicians, is integral to the continued improvement of NDBI as well as understanding of their implementation in the community. Qualitative methods (e.g., semistructured interviews) can be used to understand how autistic people and their family members view different styles of adult language input and their effect on language and communication development. Indeed, autistic people and/or caregivers may describe reasons for simplifying language input that have yet to be investigated (e.g., responding to in-the-moment cues from the child, supporting self-regulation, accommodating sensory needs). Such insights can then be used to generate hypotheses on how to further develop and improve NDBI, as well as other classes of autism interventions. Stakeholders may also indicate that they perceive artificially simplified language input as insulting or offensive (Higashida, 2013)—an unintended negative effect that could outweigh any potential benefits of extensive simplification. It is essential for clinicians delivering NDBIs to be sensitive and responsive to the cultural and linguistic diversity of their clients, taking time to assess family norms and beliefs about different styles of communication, and incorporating that information into their work together.

In addition, examining clinicians' perceptions of the acceptability, appropriateness, and feasibility of recommendations for modeling language is essential for understanding whether these practices will be implemented in community settings, particularly because professionals may have prior training that is incompatible with current evidence (e.g., encouraging telegraphic speech) or lack training in providing culturally sensitive services (e.g., emphasizing Western norms over their clients' cultural norms and values; Venker, Yasick, & McDaniel, 2019; Weiner et al., 2017). The evidence base notwithstanding, qualities of an intervention, such as complexity, acceptability, and relative advantage are likely to affect whether or not individuals will adopt an intervention practice (Rabin & Brownson, 2017). These implementation outcomes can be conceptualized as important preconditions for clinical outcomes, given that interventions must be used in order to be effective (Proctor et al., 2011).

CONCLUSION

The way we talk to children matters. As interventionists, it is our goal to ensure that autistic children are consistently exposed to adult language input that supports the development of their language and communication skills. However, we still have a lot to learn about what constitutes optimally beneficial language input for autistic children and whether it differs from their nonautistic peers. Because NDBI purposefully change the language environment for these children, we have an ethical responsibility to ensure that we are changing it in ways that are beneficial. This is particularly true when parents and caregivers taking part in an NDBI are instructed to change the way they talk, which may have wide-reaching effects on the language input children are exposed to in their everyday lives. Given the limited evidence to support the use of drastically simplified input, we must be cautious in the recommendations we give to parents and caregivers (Bottema-Beutel & Kim, 2021).

It is our hope that this commentary will help to focus current energy and excitement around the active ingredients of NDBI and generate productive, interdisciplinary conversations that will meaningfully advance autism intervention research and evidence-based clinical practice. Indeed, clinical scientists have emphasized that integrating developmental science into NDBI is not a single, discrete action, but an ongoing process that must keep pace with the generation of new knowledge (Vivanti et al., 2018). This process is necessary to ensure that our clinical practices continue to be refined in ways that maximize intervention outcomes and improve quality of life.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ETHICS STATEMENT

Autism interventions commonly recommend that adults extensively simplify their spoken language to help children understand what they say, but scientific evidence suggests that this practice may not be beneficial. In fact, recent research points to the benefits of using natural speech, rather than speech that is extensively simplified or grammatically incomplete. Because NDBI purposefully change the language environment for autistic children, we have an ethical responsibility to ensure that we are changing it in ways that are beneficial.

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