VISUAL ATTENTION TO THE CLINICIAN'S FACE AND MORPHEME ACQUISITION DURING CONVERSATIONAL RECAST TREATMENT

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF SPEECH, LANGUAGE, AND HEARING SCIENCES

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

2019

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Master's Committee, we certify that we have read the thesis prepared by Alana Glickman, titled "Visual Attention to the Clinician's Face and Morpheme Acquisition during Conversational Recast Treatment" and recommend that it be accepted as fulfilling the dissertation requirement for the Master's Degree.

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Final approval and acceptance of this thesis is contingent upon the candidate's submission of the final copies of the thesis to the Graduate College.

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Abstract

Purpose. Enhanced Conversational Recast treatment is an input-based language therapy technique designed to help children with language disorders acquire missing grammatical morphemes in their speech. This version of conversational recast treatment requires clinicians to obtain the child's attention before delivering each recast. This study examined the relationship between children's looking behaviors in response to the clinician's attentional cues and target morpheme acquisition.

Method. Children received approximately 5 conversational recast treatment sessions per week for a total of 5 weeks. Progress was monitored through generalization probes assessing target morpheme use in untreated contexts. Video recordings of sessions were coded for children's visual attention to their clinician's face during the delivery of each treatment dose (i.e., recast). Reliability of coding was high.

Results. Correlations between looking behaviors in response to attentional cues and performance on measures of generalization of morpheme use indicated a significant but negative association.

Discussion. The results suggest that providing attentional cues prior to delivering treatment doses during conversational recast treatment may detract from the child's attention to the relevant linguistic input, and decrease learning. Caution is warranted about this conclusion due to the possibility of clinician bias, and because coding from videos resulted in varying numbers of usable data points per session and per child.

Visual attention to the clinician's face and morpheme acquisition during conversational recast treatment

Developmental Language Disorder (DLD, formerly called specific language impairment) is a condition in which children display notable difficulties acquiring their native language. These difficulties cannot be accounted for by other handicapping conditions such as intellectual disability, hearing loss, or neurological disorders (Bishop, Snowling, Thompson, Greenhalgh, & the CATALISE-2 consortium, 2017). Children with DLD struggle with multiple aspects of language including phonology, morphology, and syntax. One hallmark feature of young children with DLD is the omission of grammatical morphemes, small language units that convey meaning about grammatical person, tense, and number (Rice & Wexler, 1996). For example, a child with DLD might say "frog jump" instead of "the frog jumped," thus failing to communicate that he was talking about a specific frog, and that the action happened in the past. The pattern of omitting morphemes is common among typically developing toddlers, but is usually eliminated by the preschool years. Children with DLD however, can show persistent problems with morphology well into childhood (Rice, Wexler, & Hershberger, 1998), making it difficult for other children and adults to understand them. Poor morphological awareness has also been shown to predict difficulties with early literacy and spelling in first grade children (Apel & Lawrence, 2011), as well as reading comprehension and writing difficulties in second and third grade students (Apel, Wilson-Fowler, Brimo, & Perrin, 2012). Even individuals with DLD who no longer display apparent deficits in their spoken language may struggle with persistent language-based learning disabilities as they grow older, where deficits are evident in their reading and writing (Catts, Fey, Tomblin, & Zhang, 2002; Williams, Larkin, & Blaggan, 2013).

Difficulties with literacy appear to be less severe in adolescence for individuals whose spoken language deficits had significantly improved by the time they were 5-and-a-half years old (Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). Thus, early intervention to address spoken language deficits is crucial. Children with DLD benefit from targeted language intervention (Leonard, Camarata, Pawlowska, Brown, & Camarata, 2006) in order to acquire missing grammatical morphemes to help them become more successful at communicating their thoughts and ideas.

Treatment methods that rely heavily on clinician input, such as conversational recast treatment (see Cleave, Becker, Curran, Owen Van Horne, & Fey, 2015 for review) have shown to be successful in helping children with DLD acquire grammatical morphemes in their spontaneous speech. In conversational recast treatment, the clinician sets up opportunities to encourage the child to produce grammatical forms through engaging activities such as pretend play, art projects, and dialogic reading. Once the child attempts to use a grammatical morpheme or omits a morpheme in an obligated context (e.g., “the pizza hot.”), the clinician restates the semantic content of the child’s utterance, but with correct grammar (e.g., “the pizza <u>is</u> hot.”). Immediately restating the child’s intended utterance in its grammatically correct form is referred to as a *recast*. Following a recast, the child is not explicitly asked to repeat the clinician, allowing learning to occur implicitly. Conversational recast methods take advantage of the way children naturally learn language by providing many exemplars of the child’s target language form(s), but in a condensed amount of time. This facilitates the natural phenomenon of statistical learning, the inadvertent detection of patterns and regularities in speech and language that occurs through exposure to linguistic input (see Plante & Gómez, 2018).

Despite the repeated success of conversational recast treatment, the components that actually drive change remain unknown. One factor that may impact the degree to which conversational recast treatment is effective is attention to the clinician's input. While statistical learning is traditionally thought of as occurring unconsciously in the absence of deliberate attention to the relevant input (e.g., Saffran, Newport, Aslin, Tunick, & Barrueco, 1997), research has shown that learning is unlikely to take place if attentional resources are simultaneously being devoted to other demanding tasks. In a basic research study, Toro, Sinnett, and Soto Faraco (2005) investigated the role of attention on language learning. The authors found that when participants attended to a speech stream in an artificial language, they were able to detect patterns analogous to grammatical morphology without being explicitly instructed to do so. However, when attentional resources were diverted to other tasks while listening to the speech stream, participants were unable to detect patterns. Thus, it may be beneficial to explicitly require children to attend to the clinician's input during treatment, decreasing the chances that they devote their attention elsewhere and increasing the potential for statistical learning to take place.

Attention to the clinician's input during language therapy may be especially important for children with DLD, as this population often displays subtle attention deficits compared to their typically developing peers (see Ebert & Kohnert, 2011 for review). The construct of attention is often explained through a limited capacity model, indicating that individuals possess a finite amount of attentional resources (i.e., "mental energy") to allocate to given tasks, and that task performance will be impaired when attentional resources are depleted (Pashler & Johnston, 1998). With this model in mind, children with limited attentional capacities may be restricted in the quantity of information they can process at a given time (Montgomery, Evans, & Gillam, 2009). It is possible that the attentional limits of children with DLD are already pushed to capacity by the engaging therapy materials utilized in treatment to promote conversation, and thus these children may be unable to extend adequate attention to the therapeutic element of treatment, the clinician's input. Thus, input-based treatment paradigms such as conversational recast treatment may be more effective if the child is required to explicitly attend to the clinician while he or she provides input. Interestingly, Spaulding, Plante & Vance (2008) found that in children with DLD, auditory attention for both linguistic and nonlinguistic stimuli was impaired, however visual attention was comparable to that of typically developing children (but see Finneran, Alexander, & Leonard, 2009). This suggests that children with DLD may be able to take advantage of visual cues, such as articulatory gestures (i.e., looking at the speakers lip, tongue, and jaw movements) in order to offset their auditory attentional challenges and enhance the speech signal.

Encouraging visual attention to the clinician's face during input-based language therapy may not only decrease the likelihood of inattention to the therapeutic input, but also allow children to take advantage of multimodal sensory information to enhance the salience of the clinician's input. When adult listeners have access to both auditory and visual information, they display increased comprehension of speech as compared to having access to the auditory modality alone (Reisberg, McLean & Goldfield, 1987). This phenomenon seems to be present very early in life, as infants as young as two months old are sensitive to correspondences between auditory and visual speech (Patterson & Werker, 2003). Infants rely on visual cues to help increase the salience of a message before they gain proficiency in language (Lewkowicz & Hansen-Tift, 2012). Additional research has shown that the amount of time children spend visually attending to a speaker's mouth at 6 months of age predicts their expressive language growth at 2 years of age (Young, Merin, Rogers, & Ozonoff, 2009). A study by Pons, Sanz-Torrent, Ferinu, Birulés, and Andreu (2018) found that when viewing and listening to a speaker producing a monologue in their native language, children with DLD tend to look at the speaker's eyes and mouth for approximately equal portions of time, while typically developing children spend significantly more time looking at the speaker's mouth. It is unclear, however, what role this difference plays in language learning, and whether encouraging children with DLD to direct their gaze towards a speaker's mouth would serve a role in mitigating language deficits. Although children with DLD have been shown to be less efficient at incorporating visual information than typically developing children in experimental paradigms (Leybaert et al., 2014; Norrix, Plante, Vance, & Boliek, 2007; Meronin, Tiippana, Westerholm, & Ahonen, 2013), they are nonetheless able to meaningfully benefit from visual cues to enhance speech signals in more naturalistic tasks (i.e., silent speech-reading and speech perception in noise; Knowland, Evans, Snall, & Rosen, 2016). These results indicate that children with DLD may gain expressive language skills more readily during treatment by focusing their visual selective attention on the speaker's face in order to enhance the salience of the signal by utilizing visual speech cues as well as auditory speech cues.

The present study aims to assess the impact of visual attention to the clinician's face on morpheme acquisition in children with DLD during a conversational recast treatment paradigm. We hypothesize that children who visually attend to the clinician's face while the clinician provides a recast will demonstrate stronger language gains following treatment than children who do not look, or actively avoid looking at the clinician's face. If not required to look at the clinician, a child's attentional resources may very well be dedicated elsewhere (e.g., the engaging therapy materials) rather than to the clinician's input, preventing them from learning from therapy. Additionally, children with DLD may benefit from having access to both auditory and visual modalities when interpreting speech rather than the auditory modality alone. Looking at the clinician's face while the clinician recasts allows the child to get both auditory and visual input, which facilitates language learning. In this paper, we reviewed existing treatment data (Plante, Mettler, Tucci, & Vance, submitted 2018; with additional unpublished data) to determine whether there is an association between children's looking behaviors and their treatment progress.

Method

Participants

Thirty-two native English-speaking children with DLD ranging in age from 4;1 to 5;11 (20 boys, 12 girls) participated in this study as part of a treatment research summer program conducted in 2017 and 2018 (Plante et al., submitted 2018; with additional unpublished data). Eligibility criteria included a diagnosis of DLD as evidenced by significant language impairments in the absence of other handicapping conditions, such as intellectual disabilities, neurological conditions, or sensory impairment (Bishop et al., 2017). A battery of tests was administered prior to the initiation of treatment to determine the presence of DLD, and rule out additional conditions that could potentially account for the children's language deficits. On the Structured Photographic Expressive Language Test--Preschool 2 (SPELT-P2; Dawson et al., 2003), all children received a standard score of less than 87, the empirically derived cut-off score shown to distinguish children with DLD from their typically developing peers (Greenslade, Plante, & Vance, 2009). All children received a nonverbal IQ score of at least 70 +1 SEM on the on the Nonverbal scale of the Kaufman Assessment Battery for Children, Second Edition (K-ABC; Kaufman & Kaufman, 2004), indicating cognitive skills falling above the range for intellectual disability. Children were required to pass a hearing screening at 1000, 2000, and 4000 Hz at 20 dB, and 500 Hz at 25 dB to rule out the presence of a hearing impairment. Additionally, a certified speech-language pathologist informally judged all children to be language impaired based on characteristics observed during conversational speech. Children with additional reported diagnoses such as autism spectrum disorder or neurological conditions did not qualify to participate in this study.

In addition to the battery used to qualify children for study, several supplementary measures were administered to describe the children's broader language profiles. The Peabody Picture Vocabulary Test-4 (PPVT-4; Dunn & Dunn, 2007) was given to assess receptive vocabulary at the single-word level. The Goldman-Fristoe Test of Articulation-2 (GFTA-2, Goldman & Fristoe, 2000) was given to assess and characterize articulation errors. Additionally, The Shirts and Shoes Test (Plante & Vance, 2011) was used as a receptive measure of morphosyntactic skills.

Table 1. Demographic and pretest data

Participant ID	Age	Gender	K-ABC	SPELT-P2	PPVT-4	Shirts & Shoes	GFTA-2
17-401	4;7	M	91	53	75	2	61
17-402	5;0	M	96	68	84	16	40
17-403	5;0	M	85	65	87	2	98
17-404	5;0	F	100	72	93	2	74
17-501	4;4	F	87	65	74	1	99
17-503	4;10	M	107	61	118	4	104
17-504	5;2	F	121	61	97	5	58
17-505	4;7	M	93	61	88	1	82
17-701	4;5	F	100	63	96	10	65
17-702	4;10	M	109	77	118	17	89
17-703	5;1	M	105	45	88	3	78
17-704	5;4	F	102	78	93	14	65
17-801	4;8	F	95	70	90	17	69
17-802	4;7	M	102	65	85	6	63
17-901	5;0	M	95	76	100	14	88

17-902	4;1	F	109	76	85	11	67
18-401	4;2	F	96	74	108	20	54
18-402	5;2	M	102	84	99	7	50
18-403	5;7	M	77	50	96	10	68
18-404	5;11	M	118	64	110	29	47
18-501	5;2	M	96	58	106	8	51
18-502	5;2	F	112	53	128	18	48
18-503	5;10	F	100	38	74	13	54
18-504	5;8	M	103	61	92	20	73
18-701	5;2	M	128	61	119	28	40
18-702	4;11	M	93	61	84	11	78
18-704	5;11	M	103	70	98	21	71
18-705	5;7	M	97	79	109	35	40
18-801	4;9	M	93	56	67	1	67
18-802	4;2	F	111	85	116	14	43
18-901	5;8	M	85	78	98	11	67
18-902	5;9	F	85	56	88	20	80
M	***5;0***		***99.9***	***65.1***	***95.7***	***12.2***	***66.6***
(SD)	***(6.1 mos)***		***(10.9)***	***(10.9)***	***(14.4)***	***(8.7)***	***(17.3)***

Note. Age (years; months). F = female; M = male. K-ABC = Kaufman Assessment Battery for Children, Second Edition, Nonverbal scale; SPELT-P2 = Structured Photographic Expressive Language Test – Preschool Second Edition; PPVT-4 = Peabody Picture Vocabulary Test – Fourth Edition; GFTA-2 = Goldman-Fristoe Test of Articulation – Second Edition. All test scores are standard scores with a mean of 100 (*SD* = 15) with the exception of The Shirts & Shoes Test (*M* = 10, *SD* = 3).

Procedures

Treatment Overview

All children received Enhanced Conversational Recast treatment. Below we provide a brief overview of the treatment components that were relevant for this study; however, detailed descriptions of the treatment method are reported elsewhere (Meyers-Denman & Plante, 2016; Plante, Tucci, Nicholas, Arizmendi, & Vance 2018). Sessions were held as part of a research-based summer camp program at a preschool facility affiliated with the University of Arizona. Children were treated for approximately five 15- to 30-minute sessions per week over the course of five weeks (total number of sessions attended ranged from 18-25. Mean=23.6; Mode=24). Each child received 24 doses of therapy (i.e., recasts) per session. After completing three probe sessions to determine the nature of morphological errors, each child was assigned one target to address during therapy. Targets consisted of morphemes or grammatical forms (e.g., wh-questions, contracted negatives) that children omitted or used incorrectly in obligatory contexts in at least 70% of opportunities throughout the probe sessions. Targets addressed included regular past tense (i.e., –ed; n=13), third person singular (i.e., –s; n=10), present progressive (i.e., is verb-ing; n=3), possessive (i.e., –'s; n=2), negation (i.e., doesn't; n=2) and wh- questions (i.e., what does; n=2). All sessions were video recorded.

Enhanced Conversational Recast. Enhanced Conversational Recast treatment follows a similar protocol to other forms of conversational recast treatment (e.g., Camarata, Nelson, & Camarata, 1994; Fey, Leonard, Bredin-Oja, & Deevy, 2017; Leonard, Camarata, Brown, & Camarata, 2004), with a few additional required elements. In Enhanced Conversational Recast, each child is assigned a specific target grammatical form to work on, rather than the clinician generally recasting all grammatical errors the child produces. The clinician provides the child with an obligatory context to elicit the use of the child's target morpheme within the context of a specific verb or noun (e.g., to elicit the use of "galloped" for a child with a target morpheme of past tense –ed, the clinician may say, "Look at the horse. He likes to gallop. Gallop, horse, gallop! What just happened with the horse?"). Note that none of these verb models included the target grammatical form. In addition, following the work of Plante et al. (2014), Enhanced Conversational Recast requires that the clinician recast each child's productions in the context of 24 unique verbs or nouns per session, taking advantage of the finding that variability in stimuli enhances learning (Plante et al., 2014). Finally and most pertinent to the present study, Enhanced Conversational Recast requires that the clinician recruit the child's attention to the clinician's face prior to each dose of therapy. The method used to elicit attention can differ between children depending on what is most effective after a trial-and-error period with each child, and may include visual cues (e.g., pointing to the clinician's own lips), tactile cues (e.g., gently touching the child's cheek), and verbal cues (e.g., "look at me."). These cues may be faded as the child begins to consistently attend independently. Although the clinician attempts to elicit the child's attention prior to each recast, it is impossible to guarantee that the child will actually look at the clinician. In fact, many children in the present study tended to avoid looking at the clinician's face during therapy, even in the presence of salient attentional cues. Children's responses to the clinician's attentional cues, obtained from video recordings, served as the focus of the present study.

Generalization Probes. Throughout the course of treatment, the clinicians collected probe data to monitor children's progress with their assigned target morphemes three days per week (Mondays, Wednesdays, and Fridays). During each probe session, clinicians recorded data on 10 child attempts (elicited or spontaneous) at producing target morphemes in the context of verbs or nouns from a list of untargeted words in order to assess generalization of target forms to untreated contexts. Clinicians did not provide recasts or otherwise indicate the accuracy of the child's productions during probe sessions. Probe data from each Wednesday of treatment is used as the measure of treatment progress in this study. In cases in which a child was absent on a Wednesday, data was taken from the following probe day. When children were absent on both Monday and Tuesday of the same week, Wednesday's session was scored for eye gaze, and probe data from Friday was used.

Probe Fidelity and Scoring Reliability. Observers rated the fidelity of 22% of probe sessions to assure that clinicians administered probes according to protocol. Observers monitored whether clinicians obtained exactly 10 samples of the child's production of their target morpheme (99.7%), and whether the clinician provided an obligated context for target morpheme use (98.8%). They also scored whether the clinician avoided modeling the child's target morpheme prior to elicitation (99.9%), and whether the clinician avoided providing feedback (98.9%). Additionally, observers rated whether the clinician elicited productions using both the words and materials reserved for probe sessions (99.7% and 100% respectively).

An individual who was blind to children's progress during treatment scored point-to-point reliability for children's productions during 21% of probe sessions live from the treatment room. Percent agreement was 96.7% (range= 60%-100%, mode=100%).

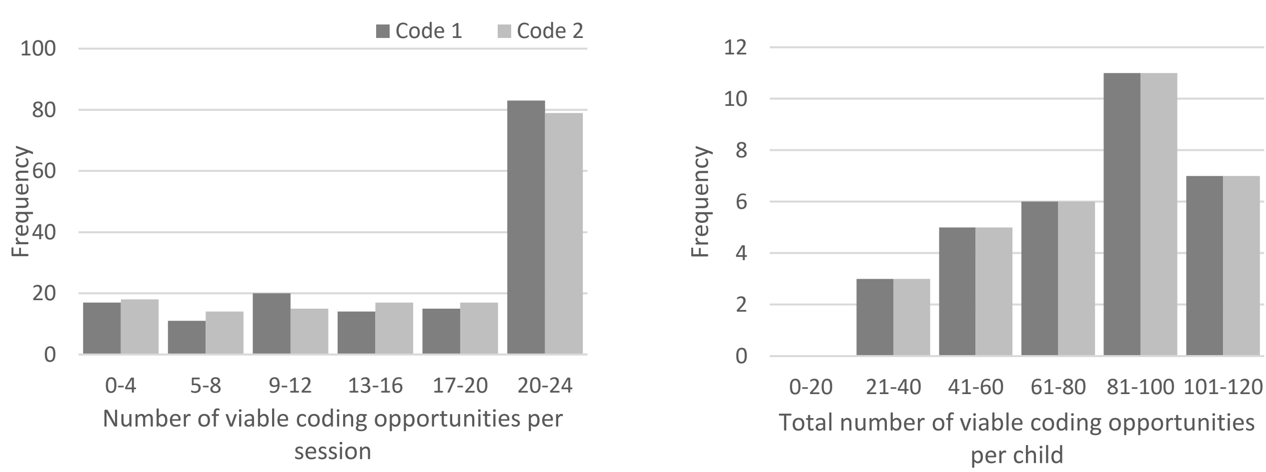
Attention to the Dose. As a component of the original study that these data were derived from, some children received all 24 recasts within a 30 minute period (n=21), while others' sessions were condensed into a 15 minute period (n=11). The results of the original study showed that dose density was not related to treatment outcomes (Plante et al., submitted 2018).

Eye Gaze Code

Undergraduate research assistants coded videos of therapy sessions to determine the frequency with which children visually attended to the clinician's face during recasts. Because each session contained 24 recasts, each video contained 24 potential coding opportunities. Coders recorded the following information for each coding opportunity: 1) whether children visually attended to the clinician's face at any point during the clinician's recast (e.g., any point during the sentence, "the caterpillar munches"), and 2) whether children visually attended to the clinician's face throughout the entirety of the clinician's production of the child's target morpheme (e.g., the "es" in "munch<u>es</u>"). Coders scored videos of all sessions from each Monday throughout the treatment program, for a total of 5 sessions per child spread over the course of the treatment duration. In cases when a child was absent on a Monday, coders scored videos from the next available treatment session (typically 1-2 days later). One child (17-503) was absent for the last several days of the treatment program, so only 4 of his sessions were scored. Individual coders were assigned to score videos of sessions completed on one to two dates per summer, decreasing the likelihood of bias based on perceived improvement for any individual child.

As this is a retrospective study and the videos were not recorded for the purpose of examining eye gaze, it was not uncommon for children to be off camera for a portion of the session, or for a child to have his or her back to the camera for several minutes at a time. In these instances, the coders were unable to determine whether the child was looking at the clinician. Thus, the data is somewhat reduced in quantity relative to an optimal 24 opportunities per video. The average number of viable opportunities for coding per session was 16.2 with a range of 0 to 24 (SD= 8.0) per session for Code 1, and 16.0 with a range of 0 to 24 (SD=8.0) per session for Code 2. For each child across all five coded sessions, the average number of opportunities for coding was 80.8 with a range of 23 to 114 (SD= 22.3) for Code 1, and 79.9 with a range of 22 to 116 (SD=24.9) for Code 2. See Figure 1 for a distribution of viable coding opportunities per session and per child across all coded sessions.

Figure 1. Distribution of number of coding opportunities per session and per child



Note. 160 sessions were coded in total. Code 1= whether the child visually attended to the clinician's face at any point during the clinician's recast; Code 2= whether the child visually attended to the clinician's face throughout the entirety of the clinician's production of the child's target morpheme.

Coding Reliability. Prior to beginning to code for the study, each research assistant underwent a training period which consisted of independently coding at least three practice videos followed by detailed feedback from the first author. Coders were required to demonstrate at least 90% agreement with the first author on both codes before being cleared to code for the study.

Twenty percent of videos were evaluated for reliability of coding. The first author double-scored approximately twenty-percent (mean= 22%; range= 17.2%-28.6%) of videos coded by each research assistant (n=7) steadily throughout the coding process in order to check for slippage in coding accuracy over time. Three to four sessions per date were scored for reliability, resulting in one session being scored per child. Research assistants were unaware of which videos would be scored for reliability prior to coding. Once videos were double-scored, coders were provided with feedback regarding any discrepancies. The average coding reliability for whether the child visually attended to the clinician's face at any point during the clinician's recast (i.e., Code 1) was 96.8% (range: 88%-100%), and 94.9% (range: 88%-100%) for whether the child visually attended to the clinician's face throughout the duration of the clinician's production of the child's target morpheme (i.e., Code 2).

Results

Descriptive statistics for each construct of eye gaze as well as treatment outcome measures are presented in Table 2.

Table 2. Descriptive statistics

		Per session			Total		
		mean	SD	range	mean	SD	range
Code 1:	# of coding opportunities	16.2	8.0	0-24	80.8	22.3	23-114
	% child looked at clinician's face at any point during clinician's recast	69.3%	30.1%	0%-100%	70.7%	22.3%	13.5%-98.9%
Code 2:	# of coding opportunities	16.0	8.0	0-24	79.9	24.9	22-116
	% child looked at clinician's face throughout the clinician's production of target morpheme	43.0%	31.8%	0%-100%	43.0%	22.4%	0%-79.4%
Outcome measures	% Accuracy during probe sessions	37%	3.6%	0-100%	37%	13%	0%-84%
	Effect size *(d)**				6.2	6.0	-1.2 - 17.3

* Treatment related change *(d)* is calculated as (mean correct morpheme use during final 3 probe sessions - mean correct morpheme use during initial 3 probe sessions)/standard deviation of the final 3 probe sessions. In cases in which there was no variance for the three final probe sessions, the minimum possible standard deviation was used to calculate *d*.

To determine whether there was a relationship between child looking behaviors and morpheme acquisition during treatment, we compared each construct of eye gaze to accuracy during generalization probes. We first examined whether visual attention to the clinician's face at any point during the recast (as measured by Code 1) facilitated morpheme acquisition, with the number of correct target morpheme productions during weekly generalization probes serving as the dependent variable. We found a significant negative correlation between these two variables r= -.44, p=.0109. We also examined whether visual attention to the clinician's face specifically during the clinician's production of the child's target morpheme within the recast (as measured by Code 2) was related to performance on generalization probes. This measure also showed a significant negative correlation, r= -.44, p=.0115.

Additionally, we compared both measures of eye gaze to children's final treatment outcomes as defined by their treatment effect size *(d)*, a measure used to interpret the strength of change in target morpheme use between the start and end of treatment. Treatment effect size was calculated using the formula described in Plante et al (2014): (mean correct morpheme use during final 3 probe sessions - mean correct morpheme use during initial 3 probe sessions)/standard deviation of the final 3 probe sessions. In cases where children showed no variance in their final three probe sessions, the minimum possible standard deviation was used (i.e., .58; the standard deviation that would have occurred if the child's morpheme use varied by a single item on one of the three final probe days). The standard deviation of the final three probe sessions was used rather than a pooled standard deviation due to the lack of variance during pre-treatment probes, as only morphemes that children produced with minimal frequency during the first three probe sessions were targeted during treatment. Both eye gaze constructs (Code 1: The frequency with which children visually attended to the clinician's face at any point during the recast; Code 2: The frequency with which children visually attended to the clinician's face when the clinician produced the child's target morpheme) were significantly negatively correlated with treatment effect size *(d)*, r= -.55, p=.0011 and r= -.50, p=.0038 respectively. See Table 3 for correlations between eye gaze constructs and morpheme acquisition.

Table 3. Correlations between eye gaze behaviors and treatment outcomes

	Total probe accuracy (%)		Effect size *(d)*	
	Pearson's correlation (r)	p	Pearson's correlation (r)	p
Code 1: % child looked at clinician's face at any point during clinician's recast	-.44*	0.0109	-.55**	0.0011
Code 2: % child looked at clinician's face throughout the clinician's production of target morpheme	-.44*	0.0115	-.50**	0.0038

* p<.05; **p<.01

Discussion

The purpose of this study was to examine whether visual attention to the clinician's face during an input-based language therapy paradigm (conversational recast treatment) facilitates grammatical morpheme acquisition in children with DLD. Our hypothesis was that children who frequently looked at the clinician's face while the clinician provided recasts would demonstrate more robust morpheme acquisition than children who looked at the clinician's face less often. Contrary to our prediction, our results showed that children who tended to look at the clinician's face during recasts showed significantly *less* treatment progress than children who less readily looked at the clinician's face following the clinician's attentional cues. This was true when comparing eye gaze during treatment to progress during weekly probe sessions, and also to final treatment outcomes.

Since children with DLD tend to have limited attentional capacities (Ebert & Kohnert, 2011), we originally reasoned that restricting attention to irrelevant stimuli by explicitly encouraging visual attention to the clinician's input would make the relevant input more salient, and facilitate learning in this population. However, based on the same logic, it is possible that requiring children to consciously shift their attention from the therapy materials to the clinician's face may require a considerable amount of attentional resources, leaving little room for processing of the clinician's linguistic input. In fact, some models of attention posit that the ability to flexibly shift attention is a complex skill that relies on adequate foundational skills, including sustained attention (Garon, Bryson, & Smith, 2008), which is known to be weak in children with DLD. However, in a review of executive function abilities in children with DLD, Kapa & Plante (2015) concluded that not enough data has been collected to date to make a sound conclusion about whether attentional shifting abilities are specifically impaired in this population. Regardless of the attentional shifting abilities of children with DLD, a sizable portion of children in the current study tended to avoid looking at the clinician, seeming to actively resist the clinician's visual, verbal, and/or tactile attentional cues. Even when the clinician was able to "win the battle" for the child's visual attention, the battle itself likely took up a significant portion of the child's attentional resources, paradoxically resulting in *reduced* attention to the recast.

When taking into consideration the apparent difficulty for some children to shift their gaze away from the therapy materials and toward the clinician, the negative correlation between shifting gaze and morpheme acquisition also fits with the literature on statistical learning. Toro et al. (2005) found that statistical learning is less likely to take place if cognitive resources are devoted to other demanding tasks during the presentation of input, and looking towards the clinician prior to treatment doses proved to be surprisingly demanding for many children.

Additionally, while previous research has shown that children with DLD are able to successfully incorporate multimodal auditory and visual information to process speech (Knowland et al., 2016), their skills are impaired compared to that of typically developing children (Leybaert et al., 2014). Thus, any potential benefit achieved by requiring children to watch the clinician's mouth as the clinician provided relevant linguistic input was likely offset by the increased attentional demands of shifting from one task to another.

Limitations and Future Directions

As discussed in the Methods section, this study's data were reduced in quantity due to frequent instances in which the children's eye gaze was impossible to infer from the video recordings. Thus, children had variable amounts of sampling opportunities from which to derive a percentage of recasts for which the child visually attended to the clinician's face (m=80.8, range=23-114 for Code 1; m=79.9, range=22-116 for Code 2). Because of the significant reduction in data, these results should be considered preliminary in nature. Additionally, it is impossible to rule out that clinician bias may have confounded the results; for example, it is possible that clinicians were less stringent about requiring eye gaze for children who were perceived to be making adequate progress in treatment. However, this is unlikely since cuing attention was a required element of treatment, and was monitored through frequent fidelity checks (mean=98.8%; range=75%-100%).

Additional research is required in order to determine whether requiring that the child look towards the clinician's face before providing input reduces learning. Future experimental research should examine treatment outcomes of children who are encouraged to shift their attention to the clinician prior to each dose of therapy compared to children who are not cued to look prior to recasts.

Clinical Implications

Our findings suggest that mandating children's visual attention to the clinician's face prior to each dose of conversational recast treatment may disrupt attention to the input and reduce learning of morphological targets. It is important to realize, however, that these results do not in any way suggest that children should be actively discouraged from looking at the clinician, but rather that explicitly requiring eye contact may hinder learning. Clinicians should continue to assure that the children are generally engaged during input-based language treatment, but our data provide evidence against encouraging the child to shift their attention away from the therapy activity and towards the clinician's face.

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