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Table of Contents

GESTURES AS AN EDUCATIONAL TOOL

Can children's understanding of coherence relations benefit from the use of co-speech gestures?

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Abstract

The present research paper explores the literature on multimodality and coherence relations to propose an experiment aimed at investigating whether gestures can improve children's comprehension of contrastive coherence relations. The suggested experiment uses a video story-telling paradigm in conjunction with a Truth-Value Judgment Task (TVJT). It is expected that the employment of co-speech gestures, paired with contrastive (but) and concessive (although) connectives, will lead to more accurate responses from 5-to-6-year-olds, thus confirming the hypothesis that the deliberate use of co-speech gestures can serve as a powerful tool in an educational setting.

Keywords: *Multimodality, Co-Speech Gestures, Coherence Relations, Acquisition of Connectives, Learning*

1. Introduction

Early childhood education plays a crucial role in establishing the foundation for a child's lifelong skills. Without effective teaching methods, educators run the risk of failing to help children grasp fundamental concepts. Therefore, it is of utmost importance that research be conducted to discover more effective instructional techniques.

One such teaching technique that aims to enhance reading comprehension and writing skills in primary school students is the Talk for Writing framework (Corbett and Strong, 2017). This framework incorporates visual actions, in the form of co-speech gestures, during storytelling. These gestures help in creating a visual map of the story, supporting the learning of textual structure.

Given this context, it becomes pertinent to explore whether the use of gestures can indeed improve children's comprehension. This investigation aims to provide insights into whether metaphoric co-speech gestures can be effectively employed to aid in the teaching of coherence relations and textual structure. Consequently, an experiment is proposed to examine whether the use of metaphoric gestures during the narration of a story affects the accuracy of preschool children's understanding of complex coherence relations.

2. Theoretical background

2.1 Coherence relations and co-speech gestures

Connectives, such as 'but', 'because', 'and', and 'therefore' play a vital role in establishing links between sentences. They indicate the expected relations between two clauses, contributing to a unified and coherent discourse (Sanders et al., 1992). Coherence relations are the connections that exist between different parts of a discourse, and they are constructed through the use of different connectives. These relations are cognitive in nature, going beyond the discourse itself to form cognitive representations of the dependencies found in discourse (Sanders et al., 1992).

Similarly, co-speech gestures are also considered to be expressions of cognition, to the point of being referred to as "a window into the mind" (Lapraire, 2011, p. 83). Sweetser (2007) defends this idea by stating that gestures go beyond mere accompanying representations of speech, and contribute to the structuring of "mental spaces". Moreover, she argues that gestures have the function of embodying concepts that can be too abstract to be represented in other ways. Metaphoric gestures, which represent abstract concepts like time and space through the body's location and motion in gesture space, are a family of gestures that serve to illustrate these abstract concepts, concomitantly with speech (McNeill, 1992).

Finally, previous research indicated the important role gestures play in connecting different parts of discourse, accompanying the coherence relations established in speech (Crible & Garbarró-López, 2020; Graziano, 2014; Inbar, in press). Inbar's (in press) study, for example, observed that coherence relations expressed in speech in Israeli Hebrew are simultaneously expressed through gestures, drawing on primary physical-sensory experiences. These experiences, such as pointing toward the speaker for 'inside' or pointing away for 'outside', help to physically convey the meaning of abstract ideas related to opposition, similarity, comparison, and contrast. This leads Inbar to argue that co-speech gestures should be considered an integral part of contrastive constructions in Hebrew, highlighting the reliance on gestures to construct relations between discourse segments.

2.2. Acquisition of coherence relations and co-speech gestures

Elaborating on the taxonomy proposed by Sanders et al. (1992), Evers-Vermeul and Sanders (2009) conducted a corpus study on the emergence of Dutch connectives aimed at investigating the mechanism behind the order of acquisition of connectives. They analyzed acquisition data from children aged 1;5 - 5;6 years old, and concluded that the acquisition of connectives is related to the conceptual complexity of the coherence relations represented by the connectives. They observed that simple relations, such as additive 'and' relations, are acquired before more complex contrastive and concessive relations (e.g. causal relations). Their study shows that by 3 years of age children have already acquired the connectives for relations of contrast, as can be seen in their examples repeated here below:

(29) Slagboom gaat niet open. Maar hij kan wel erdoor. (Peter, 2;8.22)
'Barrier does not open. But he can go through.'

(25) Jij mag niet eh van drop want dat is van mij. (Thomas, 2;10.19)
'You may not uh (have) of licorice because it is mine.'

However, are 3-year-olds also gesturing to convey the relationships indicated by these connectives? Graziano (2014) investigated the relationship between the use of co-speech gestures and connectives of Italian children aged between 4 and 10 years old, which were taken as a measure for the discourse cohesion of children's narratives. She conducted a study with 33 video recordings of cartoon retellings where she analyzed the gestures used. She concluded that pragmatic gestures (i.e. gestures that convey meaning beyond their form to enhance the clarity of communication (see Kendon, 2004)) appear concomitantly with the production of connectives, and their use increases with age, an indication of the development of children's communicative abilities. These results strengthen the claim that gesture and speech are part of a unified mechanism of communication and language, with co-speech gestures becoming progressively more complex as language use becomes more complex.

Another investigation into age-related changes in co-speech gestures and connectives was conducted by Colletta et al. (2010). It looked at 6-year-olds, 10-year-olds, and adults (mean age = 21), and showed that, compared to the other age groups, 6-year-olds use more discourse cohesion markers in their narratives.

In terms of co-speech gestures, they found a significant effect of age on gesture rate, with gestures increasing as age increased, confirming that development in narrative behavior is accompanied by development in co-speech gestures.

In sum, studies indicate that younger children depend more on the use of verbal connectives when retelling a story and constructing coherence relations, and make less use of co-speech gestures in constructing discourse cohesion. Conversely, adults have shorter narratives, with more implicit connectors and more co-speech gestures to mark cohesion between clauses. This raises the question of whether encouraging the use of co-speech gestures by children could function as a springboard for introducing more complex relations to their repertoires.

2.3 Co-speech gestures and learning

Research on early language acquisition and gestures suggests that co-speech gestures can predict language development and facilitate children's learning of new words and their meanings. Iverson and Goldin-Meadow (2005) conducted a study involving 50 children aged 10 to 24 months, capturing their interactions with caregivers on video. Their findings indicated that early gestural behavior can predict the inclusion of new words in children's vocabulary and that combining gestures with words aids their transition from single to two-word combinations. For instance, the study observed that children initially pointed to the object ('bird') referred to by a word ('nap') before using both words together ("bird nap").

Their results also argue in favor of gesturing as an integral part of language acquisition and development, and of co-speech gestures playing a significant role in language learning, by anchoring children's verbal expression in a concrete visuospatial plane. This anchoring can be particularly helpful with abstract concepts, which can be more simply expressed visually than verbally, according to the authors. They put forward that co-speech gestures may pave the way for new meanings and concepts to enter the children's repertoire, which would appear first in gesture and later in speech, as their study showed.

Hence, gestures are defended as having a positive impact on word learning, as well as in language learning as a whole, by providing an outlet for producing meanings that might still be too complex to be produced verbally. Additionally, other studies on gestures and learning indicated that children benefit from gestures used in bilingual education (Church et al., 2004) and math exercises (Goldin-Meadow & Singer, 2003; Goldin-Meadow et al. 2009).

The significant benefits of communication when using co-speech gestures are further indicated by Hostetter's (2011) meta-analysis of 63 gesture studies. Her analysis highlights how gestures are particularly effective in providing additional conceptual information alongside speech, particularly when the recipient of the gesture is young and she goes on to suggest that teachers can harness the power of gestures to enhance their instruction.

Thus, all the evidence provided above supports the use of gestures as a tool for illustrating concepts to children, since it aids in grounding complex ideas, directs attention to specific correlations, and reduces the cognitive load associated with complex relations. To evaluate whether the use of gestures can enhance children's understanding of complex coherence relations, an experiment is proposed below.

3. Methodology

3.1 Research question and hypotheses

The study has two main hypotheses:

1. The use of metaphoric gestures can improve children's comprehension of complex coherence relations represented by causal connectives, such as the Dutch concessive connective *hoewel* (although) and the contrastive connective *maar* (but) (Evers-Vermeul & Sanders, 2009). As mentioned above, gestures reduce cognitive load and provide embodied experiences, thus it is expected that these gestures will enhance children's understanding of the relations.
2. Co-speech gestures can assist children in learning new words and comprehending abstract relationships in discourse segments. While previous research has highlighted the benefits of gestures in math and language (Church et al., 2004; Goldin-Meadow & Singer, 2003; Hostetter, 2011; Mumford & Kita, 2014), their potential role in coherence relations within educational contexts remains unexplored. It is expected that gestures enhance the comprehension and learning of abstract relations, enabling children to use these connectives more frequently in naturalistic speech.

3.2 Participants

The study focuses on testing 5- to 6-year-old children, who are at a stage when they already possess some connectives in their vocabulary and can benefit from the use of gestures in comprehension (Evers-Vermeul & Sanders, 2009; Mumford & Kita, 2014).

A total of 45 participants will be tested, with 15 in the target condition (gestures for connectives), 15 in the control condition (no gestures for connectives), and 15 adults for comparison. Including adults as controls helps assess any unrelated difficulties that may affect children's responses in the Truth-Value Judgment task, which will be employed during the experiment. The children will be recruited through a partnership with a Dutch primary school and will be assessed for vocabulary development with a MacArthur Bates Communicative Development Inventory (MB-CDI) in Dutch.

3.3 Experimental method and variables

The Truth-Value Judgement task (TVJT) is a reliable method for measuring children's language acquisition. It involves judging the truth or falsehood of affirmations about a story. The TVJT was chosen to measure children's comprehension of complex coherence relations in the experiment. Therefore, two stories (experimental condition and control condition) will be presented to the participants, interspersed with the TVJT related to the story. The experimental condition will contain iconic gestures for the characters (e.g. hands over the head mimicking ears for a rabbit character) and metaphoric gestures for the contrastive connectives (e.g. raised hand and arm moving from right to left of gesture space for the connective 'but'). The control condition video will only consist of the iconic gestures of the characters. The independent variable is the use of co-speech gestures for connectives during story-telling, and the dependent variable is children's accuracy of the TVJT.

3.4 Procedure and analysis

The procedure involves children watching a 5-minute video story with the experimenter and their teacher present. The experimenter takes notes on the child's gestural behavior, while the laptop's camera records their reactions. Two video conditions will be used: one with metaphoric gestures for connectives and one without. The experiment includes a training phase and a TVJT with affirmations for children to judge. The affirmations for the TVJT will be phrased differently from the video to help ensure that accurate responses are not solely due to participants' memory of the story but reflect their comprehension of coherence relations facilitated by gestures. The whole session will last around 20 minutes. After the conclusion of the experimental phase, a mixed effects logistic regression will be used to analyze the results, considering age and accuracy as fixed factors, and gender and time it took to complete each TVJT as random factors.

4. Expected results

It is predicted that metaphoric gestures will enhance comprehension, learning, and differentiation of complex relations established by these causal connectives. Consequently, children's responses to the TVJT are expected to be more accurate in the condition that displays metaphoric co-speech gestures accompanying causal connectives. Age is also expected to be positively related to higher scores on the TVJT.

5. Limitations and confounds

The main limitation is that the benefits of the 'gesturing for connectives' method may not be fully observed in just one experimental session. Thus an intervention study would be more appropriate, involving a 7-week-long training to evaluate the improvement in comprehension of coherence relations. However, previous studies on gestures and learning have demonstrated children's benefits from gestures after a single exposure (Mumford & Kita, 2014).

To address the potential challenge of children's familiarity with the connective hoewel (although), a pilot study will be conducted to test their understanding. If 5-year-olds are unfamiliar with hoewel, it will be substituted with ook al (though) in the experiment, which is composed of two words presumed to be familiar to the age group. The intelligibility of ook al will also be assessed in the pilot study.

To mitigate confounds in the experiment, participants' vocabulary development will be assessed using the MacArthur Bates Communicative Development Inventory (MB-CDI) in Dutch, during the participant selection phase. Children who already use hoewel regularly and those who have not yet begun using want (because) will be excluded from the study.

To address potential fatigue in children during the task, the story-telling portion will be kept under five minutes, and the entire experiment will not exceed 25 minutes. A cookie break will be included to keep children engaged and the TVJT questions will be interspersed throughout the story-telling to maintain interest.

6. Conclusion

Connectives play a vital role in demonstrating what are the cognitively established coherence relations between discourse segments, and metaphoric gestures provide insights into cognitive processes that construct the mental map of these relations. Thus, uniting the knowledge produced by research into coherence relations and co-speech gestures, the proposed experiment purports to investigate the effectiveness of metaphoric gestures as a teaching tool for preschoolers, to determine whether their use benefits apprehension discourse coherence relations.

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THE EFFECT OF IMPLICIT AND EXPLICIT WORD STRUCTURE PRIMING ON STATISTICAL LEARNING ABILITY IN CHILDREN AND ADULTS WITH TD AND DLD

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Abstract

Developmental Language Disorder (DLD) has been associated with linguistic and cognitive impairments. Recent studies have also found a statistical learning deficit in people with DLD. Although this might sound plausible considering the many impairments associated with DLD, information theory contradictorily tells us that people with lower memory strength should be better at rule-based learning, which is part of the statistical learning process. This article proposes a study focusing on the statistical learning ability of children and adults with DLD compared to their neurotypical peers by investigating word segmentation ability in an auditory and a visual artificial language. Additionally, it will be investigated whether implicit and explicit priming of word structure, in speech (auditory language) and in shapes (visual language), facilitates word segmentation. The relevance of this proposal is that it combines our knowledge on information theory and statistical learning in an attempt to shed more light on the statistical learning impairment associated with DLD, to obtain more knowledge about the underlying mechanisms of this neurological disorder.

Keywords: Statistical Learning, DLD, Procedural Memory, Implicit/Explicit, Word Structure Priming

1. Introduction

Developmental Language Disorder (DLD) is a neurodevelopmental condition which presents itself in 7–8% of children (Bishop, 2010). DLD has been related to several linguistic and non-linguistic impairments in the absence of other (medical) factors or deprivation from linguistic input (Leonard, 2014). Linguistically, these impairments involve language comprehension and production, especially with respect to syntactic proficiency (Bishop & Snowling, 2004; Leonard, 2014); non-linguistically, they involve, among other things, motor development, (non-)verbal working memory, and procedural memory (Leonard, 2014; Ullman & Pierpont, 2005).

Additionally, studies have shown that people with DLD are impaired in their auditory and visual statistical learning (SL) ability (Gillis et al., 2022; Lammertink et al., 2017, 2020), whereby SL in language is hypothesised to underlie syntactic proficiency (Saffran, 2003). With respect to information theory, the profile of people with DLD, of having less efficient working memory and procedural memory, suggests that they would be relatively good statistical learners. Namely, Radulescu et al. (2020b) argue that people with lower memory strength should be better at deducing rules from a pattern, which is necessary in SL. However, Gillis et al. (2022) argue that this might not have been found in previous studies because explicit learning ability aiding the detection of the triplet structure of tri-syllabic words in artificial languages might need to be activated before the SL tasks. Therefore, this article proposes a study that aims to find out whether priming with explicit knowledge about the structure of an auditory and visual artificial language supports children and adults with DLD in their subsequent SL ability in those languages. Additionally, it will be investigated whether implicit priming is already effective enough to be beneficial for SL ability.

2. Theoretical background

2.1 DLD and statistical learning

Studies have shown that DLD is related to impairments in (morpho)syntactic proficiency (Bishop & Snowling, 2004). Ullman and Pierpont (2005) proposed the Procedural Deficit Hypothesis (PDH) to explain this. The PDH posits that procedural memory is impaired in DLD. This memory system enables implicit learning of (rule-based) computational sequences including the grammar of language (Lee et al., 2020). Contrastively, the declarative memory is argued to remain intact. This memory system is involved in the explicit learning of idiosyncratic mappings, including factual (semantic/lexical) knowledge (Ullman & Pierpont, 2005).

Because DLD is related to a procedural memory deficit, it could also be related to a statistical learning (SL) impediment. SL refers to the ability to implicitly extract rule-based regularities from a stimulus over time (Schapiro & Turk-Browne, 2015). It includes two stages of identification and memorisation, whereby transitional probabilities (TPs) between words in a continuous language stream are (implicitly) identified and then stored as individual words in long-term memory (Batterink & Paller, 2017). TPs refer to the probability of syllable X being followed by syllable Y in language L.

Saffran (2003) states that infants use SL to discover patterns in sounds, words, and grammatical structure when acquiring a language. Thus, SL can be regarded as a procedural process and could therefore play a role in poor grammatical performance of people with DLD.

Several studies have shown that people with DLD have poor SL performance. When compared to typically developing peers, people with DLD (aged 6–19 years old) showed less sensitivity to statistical regularities in auditory artificial languages with speech and visual artificial languages with shapes (see meta-analysis of Lammertink et al., 2017 for speech and Gillis et al., 2022; Lammertink et al., 2020 for shapes). These studies tested artificial languages that usually included four words with a tri-syllabic structure (CVCVCV) or with three subsequent shapes, such that the TP of neighbouring syllables/shapes between words was 0.33 and between syllables within words was 1.0. Whether SL is successful depends on whether participants are sensitive to TPs. Lammertink et al. (2017) found that there is a moderate to large SL deficit in people with DLD, but that mediating factors influencing this deficit remain unknown. Nevertheless, they encourage the development of SL-based interventions that might support SL in people with DLD. Therefore, an intervention is proposed in this research proposal.

2.2 Statistical learning and information theory

For the way in which an artificial language can be learnt, Radulescu et al. (2020b) make a distinction between item-bound generalisation and category-based generalisation. Item-bound (IB) generalisation involves the memorisation of specific instances, whereas category-based (CB) generalisation occurs when there are too many specific instances to remember and it is thus more efficient to generalise by remembering the rule-based structure in the input. Radulescu et al. (2020b) propose a model that posits that input complexity, as measured by entropy, triggers IB to CB generalisation to occur. In this respect, entropy in the input is higher when an artificial language includes a bigger inventory of syllables, which results in patterns occurring less frequently compared to languages that are evenly long with fewer types of syllables. People are expected to show more IB learning when input has lower entropy and does not overload memory, but they are expected to resort to CB generalisation when input is more complex and has higher entropy.

Additionally, Radulescu et al. (2020b) mention that channel capacity is also an important factor that drives the transition from IB to CB generalisation. Namely, the brain's power to encode information from given input is finite and differs per individual.

Radulescu et al. (2020b) tested this for adults with four artificial languages, a familiarisation language, a language with new syllables and the same structure (XXY), a language with new syllables and a different structure (XYZ), and a language with the same syllables and a different structure (XYZ). Within these languages, different levels of entropy were included to test the effect of entropy on whether or not participants were more or less likely to answer correctly whether the test languages were part of the familiarisation language. It was hypothesised that higher entropy makes participants more likely to have CB generalisation, which would be reflected in a rejection of the languages with familiar syllables or new syllables and a different structure. Contrastively, it was expected that lower entropy would result in IB generalisation, which would be reflected in the results when the language with familiar syllables is accepted irrespective of a different or the same structure. The results were in line with the expectations. Additionally, the researchers mention that people with narrower channel capacity, e.g., infants, are more likely to show CB generalisation.

Moreover, Radulescu et al. (2020b) and Radulescu et al. (2020a) state that working memory supports channel capacity. This suggests that better working memory would improve channel capacity, making it more likely that IB and not CB generalisation occurs. Therefore, considering the impaired working memory and procedural memory of people with DLD (Leonard, 2014; Ullman & Pierpont, 2005), better CB generalisation is expected, which would improve SL ability. However, in section *2.1* it has already been established that this is not the case. The reason why people with DLD show a low performance in SL tasks remains unclear. Gillis et al. (2022) studied children with and without DLD with respect to a visual learning paradigm that requires the detection of triplets. They concluded that the underperformance of children with DLD might have something to do with intentional learning. They state that children with DLD may not have activated their explicit learning system that could support SL performance and that it would be interesting to investigate if the activation of explicit knowledge supports word segmentation in an SL task.

3. The present study

Considering that people with DLD have problems with SL (Lammertink et al., 2017, 2020) and the assertion that activation of explicit memory may facilitate pattern recognition and thereby CB learning and SL learning (Gillis et al., 2022), this research proposal aims to test whether the activation of explicit knowledge about the structure of a visual and auditory artificial language through priming will support SL in people with DLD compared to people with typical development (TD).

Thereby, it will be tested whether knowledge about the structure of language necessarily needs to be explicit or whether implicit exposure to the artificial language structure is already beneficial. Furthermore, both children and adults will be tested to investigate whether the narrower channel capacity of children with DLD allows them to perform better SL compared to adults. The following research question was formulated:

RQ: *How does priming with explicit and implicit knowledge about the word structure of an auditory and a visual artificial language affect the SL ability of children and adults with TD and DLD?*

Radulescu et al. (2020b) argue that people with lower memory strength, including people with DLD (Leonard, 2014; Ullman & Pierpont, 2005), should be better at CB generalisation facilitating SL. According to Gillis et al. (2022), the opposite has been shown in previous studies focusing on auditory and visual artificial languages (Lammertink et al., 2017, 2020), because it might be necessary to explicitly activate the structure of words in languages beforehand to aid later word detection in the SL task. Considering this background, the following hypotheses were formulated:

H0: *Explicit priming, implicit priming, or a combination of both, of the word structure of an auditory or visual artificial language does not affect SL performance in children and/or adults with TD and DLD.*
H1: *Explicit priming, implicit priming, or a combination of both, of the word structure of an auditory or visual artificial language affects SL performance in children and/or adults with TD and DLD.*

4. Methodology

4.1 Participants

One hundred and twenty children with DLD and 120 with TD between the ages of 9–12 years old will be recruited from special and regular primary schools in the Netherlands after parental consent is obtained. Additionally, 120 adults with DLD and 120 adults with TD aged between 18–30 years old will be recruited via Utrecht University.

All participants will be selected based on the criteria of being Dutch monolinguals without hearing disabilities, neurological impairments, or other diagnoses that can be related to language impairment (other than DLD). Socioeconomic status (SES) will be identified by means of a questionnaire about the participant's (or parents') educational level. This will be converted to a five-point scale (low-high SES).

4.2 Materials and procedure

The study will include two language conditions with an auditory and a visual artificial language. Each of the four groups of participants will be randomly divided over the two language conditions. The experiment will consist of three phases. Phase 1 includes three priming conditions: An explicit priming condition, implicit priming condition, and no priming condition. Participants will be randomly assigned to one of the priming conditions. Thus, eventually, twenty participants per group will have performed the experiment in the same language and priming condition, resulting in a between-participants design. Phase 2 is the exposure phase, whereby participants will either be exposed to the auditory or to the visual artificial language. In Phase 3, it will be tested whether participants succeeded in word segmentation through SL.

4.2.1 Phase 1: Word structure pairing

Phase 1 aims to show whether or not an explicit or implicit priming condition, with a no priming control condition, will support SL performance. Before the start of this phase, participants will be told that they are going to listen to (in the auditory experiment) or look at (in the visual experiment) words in an artificial language. In the no priming condition, participants will be skipping Phase 1 and continuing with Phase 2. In the implicit priming condition, participants will listen to or will be shown 10 tri-syllabic words such as the ones in the artificial language that they will hear/see in Phase 2. These words will have the same CVCVCV structure as the words in Phase 2 (see section 4.2.2), but will be made up of different syllables (sounds or shapes) to not prime participants about the specific words that have to be segmented. These words will be played or shown one by one. In the explicit condition, participants will be told that the language they will hear or see includes words with a structure of three syllables or three shapes, with an explanation of what syllables are and the same examples used in the implicit condition. In all conditions, participants will not be told what to pay attention to or what they will do in Phases 2 and 3.

4.2.2 Phase 2: Exposure to the artificial language

The auditory artificial language that will be used for this study will be taken from Daniel's (2017) audio file. This file includes a language that was developed by Saffran et al. (1996). It includes a stream of four tri-syllabic words that have a CVCVCV structure. In total, there are 363 syllables (and 121 words) that are presented in randomised order throughout the speech stream, with a TP of 1.0 between syllables within words and 0.33 between syllables across words. The stream is 133 seconds long, which amounts to .37 seconds per syllable and 2.7 syllables per second. The syllables that make up the words are all different, suggesting there are 12 different syllables. For the present study, the audio will be cut short so that 120 words are played, for all four words to be played equally often, i.e. 30 times each.

The visual artificial language will have the same words and structure as the auditory artificial language. However, the syllables will be exchanged by shapes to allow for a non-verbal and domain-general test. This language will be included in light of people with DLD's language difficulties. Therefore, they might perform better on a visual SL task. The idea to exchange syllables for shapes is based on the study of Abla and Okanoya (2009), who proposed a visual SL task with shapes. In the present study, a different shape will be matched to each syllable in the auditory artificial language to be able to compare results across the languages. Thus, each tri-syllabic word of three shapes will be repeated 30 times throughout the artificial language in a video, whereby the shapes will be shown one by one, similar to what happens in auditory language. The video will be longer than the audio of the auditory artificial language, because it will have to be slowed down for participants to be able to visually process the shapes, as visual processing is slower than auditory processing (see Breznitz & Meyler, 2003).

Because artificial languages are learnt implicitly due to procedural memory being involved, it has been recommended to distract participants during exposure to the artificial languages (Lee et al., 2020). Therefore, participants will colour a mandala during exposure to the auditory artificial language and a musical tune will be played in the background of the visual artificial language.

4.2.3 Phase 3: Test phase

Two conventional tests will be conducted in the test phase. During the Accuracy Rating Task, four words from the artificial language and four part-words will be presented twice each, producing a total of 16 test items. The part-words will be different in that their medial syllable (or shape) will be switched with the medial syllable of another word, decreasing the TP between words.

Participants will be presented with individual test-items (shapes will be shown one shape at a time) and have to fill in yes or no to whether or not they heard or saw the 16 (part-)words in the auditory or visual language stream. If participants obtain a score of ≥60–65% they will have successfully 'learnt' the languages. The Appendix shows the one-to-one mapping of syllables onto shapes in Table 1 and the words and part-words that will be used in this task in Table 2.

Afterwards, a Target Detection Task will be conducted to test participants' ability to predict when the next syllable or shape will be presented. During this task, participants have to press the spacebar each time they hear or see the syllable or shape in a stream of the language they listened to, while their reaction times will be measured. Each stream will include five of the words, with a total of 20 words per stream, so participants have to detect a target syllable or shape five times per stream. Each syllable or shape in the artificial language will be the target twice, adding up to 24 streams in total.

5. Expected results and discussion

Firstly, it is expected that children will perform better than adults on both the auditory and visual language conditions, due to their lower channel capacity aiding them in making CB generalisations that are necessary in these complex tasks (Radulescu et al., 2020b). However, it is not expected that children and adults with DLD will outperform their peers with TD. Namely, even though they are likely to have a narrower channel capacity, considering their less efficient working memory and procedural memory (Leonard, 2014; Ulman & Pierpont, 2005), previous studies have shown that people with DLD are outperformed by people with TD on both auditory and visual SL tasks (Lammertink et al., 2017, 2020).

Although it is expected that the TD group will outperform the DLD group, it is also expected that this difference will be smaller in the visual language condition, because it is domain-general and people with DLD have language deficits. The difference may also be smaller in the implicit and explicit priming conditions compared to the no priming condition. Furthermore, performance in the DLD groups after explicit or implicit priming may show similar results to TD performance without priming, because priming is expected to attract attention to triplets, which may make it easier for children and adults with DLD to compute the TPs in the stimuli to correctly identify word boundaries.

This is based on Gillis et al. (2022) who mention that explicit priming may promote more activation of explicit thinking about the stimuli, which they state to be necessary to deduce rules from a pattern. Therefore, it is also expected that results might be better after the explicit priming compared to the implicit priming condition, because that condition draws more attention to the language structure. On the other hand, if both people with TD and DLD do not perform measurably better on the explicit/implicit priming conditions vs. the no priming condition, this could mean that priming by focusing on language structure does not support CB generalisation. However, more interestingly, if only people with DLD do not perform measurably better in the priming conditions vs. no priming condition, it could mean that children with DLD, despite their narrower channel capacity and lower memory strength, are not able to deduce rules from the input by analysing TPs, even after being supported by priming.

If the latter result is found, it could be argued that the fact that people with DLD have impaired memory might result in their inability to make IB generalisations, which are hypothesised to necessarily precede CB generalisations (Radulescu et al., 2020b). In that case, supporting language structure might not be useful because people with DLD might first need support in making IB generalisations. Then, a follow-up study could investigate whether, for example, familiarisation with the syllables/shapes in the artificial languages might decrease entropy and thereby improve IB generalisation which could aid CB generalisation ability. It should be considered that little is known about the underlying issues in DLD and, therefore, there might also be other factors that prevent people with DLD from performing CB generalisation if it turns out that they have no trouble with IB generalisation.

6. Conclusion

This article proposed a study that will investigate the statistical learning ability of children and adults with TD and DLD in an auditory and visual artificial language. Additionally, it was discussed that an intervention of implicit and explicit word structure priming could support word segmentation, especially for children and adults with DLD, who have difficulties in this area. This study can give us more insight into whether drawing attention to word structure can facilitate word segmentation for children and adults with TD and DLD. It can also open up possibilities for future research to further explore the unknown mechanisms involved in the language difficulties that are associated with DLD. Ultimately, the findings of this proposed research could bring researchers one step closer to developing an effective teaching intervention that language therapists in clinical settings and teachers at schools for children with DLD can use to facilitate language acquisition and increase language proficiency.

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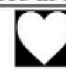
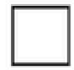
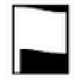
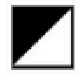
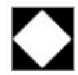
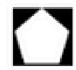
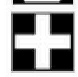
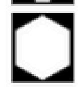
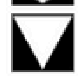
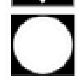
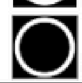
Appendix

Syllables of the Auditory Artificial Language as Matched by Shape in the Visual Artificial

Number	Syllable	Shape name	Shape picture (to be used in test)
1	bu	heart	
2	la	square	
3	do	flag	
4	bi	half_triangle	
5	ti	star	
6	ba	diamond	
7	ta	pentagon	
8	go	cross	
9	ku	hexagon	
10	da	full_triangle	
11	du	circle	
12	pa	empty_circle	

Note. The shapes are white on a black background, because this makes it more comfortable to look at on a screen.

Table 2

Words and Part-Words in the Auditory Artificial Language as Matched by Shape in the Visual Artificial Language That Will be Used in the Test Phase

	Auditory artificial language	Visual artificial language
Words	bigoku	half_triangle cross hexagon
	bulado	heart square flag
	tadupa	pentagon circle empty_circle
	datiba	full_triangle star diamond
Part-words	tagopa	pentagon cross empty_circle
	dalaba	full-triangle square diamond
	butido	heart star flag
	biduku	half_triangle circle hexagon

ON TWO TYPES OF AGREEMENT IN TAMIL

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Abstract

The present work investigates a phenomenon in the Dravidian language Tamil relating to two types of verbal agreement, a semantically empty one, and a semantically meaningful one. I present data that shows that both within and across dialects, the appearance of overt agreement on the verb sometimes correlates with the presence of a strong intentionality reading, a phenomenon which has not previously been investigated or explained from a structural perspective. I propose, following an account by Diercks et al. (2020) of anaphoric complementiser agreement in the Bantu language Lubukusu, that Tamil possesses two kinds of φ-feature bundles, an unvalued uninterpretable bundle which makes no semantic contribution, and an unvalued interpretable (anaphoric) bundle which does make a contribution. Furthermore, in line with Sheehan and Hinzen (2011), who postulate that the nature of phase edges determines the referential properties of a phase, I argue that while uninterpretable φ-features merge at T, interpretable φ-features merge at C, thus making the clause more referential, and resulting in the strong intentionality reading.

Keywords: Syntax, Verbal Agreement, Intentionality, Phases, Tamil

1. Introduction

In many dialects of Tamil including Standard Indian Tamil (SIT), the verb in a declarative clause necessarily and overtly agrees in person and number in the first and second persons, and person, number, and gender (or φ-features) in the third person as shown in (1). While masculine, feminine, and neuter are separate in the third person singular, in the third person plural, there is only a distinction between neuter, and non-neuter for male or female referents (abbreviated 'MF' here for 'male-female').

(1) a. nāṉ pō-kiṟ-ēṉ (SIT)

I.NOM go-PRS-1SG

'I go.'/ 'I am going.'

b. nī pō-kiṟ-āy

you.NOM go-PRS-2SG

'You go.'/ 'You are going.'

c. avaḷ pō-kiṟ-āḷ

she.NOM go-PRS-3SG.F

'She goes.'/ 'She is going.'

d. avarkaḷ pō-kiṟ-ārkaḷ

they.NOM go-PRS-3PL.MF

'They go.'/ 'They are going'

e. atu pō-kiṟ-atu

it.NOM go-PRS-3SG.N

'It goes.'/ 'It is going.'

Cross dialectally however, other patterns can be seen. Consider the paradigm presented below from Negombo Fisherman Tamil (NFT), a dialect spoken by a small community in western Sri Lanka. In the spoken language, the verb does not show overt agreement with the subject, primarily in the present and past tenses, as well as perfective and progressive aspects (Bonta, 2010) as shown in (2) (Bonta, 2010, pp. 314-316).

(2) a. nāṉ pō-ra (NFT)

I.NOM go-PRS

'I go.'

b nāŋga pō-ra

we.NOM go-PRS

'We go.'

c. avaŋga pō-ra

they.NOM go-PRS

'They go.'

d nāṉ kudu-tta

I.NOM give-PST

'I gave.'

e. aven kudu-tta

he.NOM give-PST

'He gave.'

Of particular interest to the present work is that when overt agreement is present in NFT, namely first-person singular or plural agreement in the present and future tenses, it conveys strong intention. This is illustrated in (3) (Bonta, 2010, pp. 316-317, emphasis added).

(3)	a.	nāṉ	avaŋga-ukku	kaðai-cciy-**en**		(NFT)
		I.NOM	they-DAT	speak-PRS-1SG		
		'I intend to speak to him.'				
	b	nāŋga	ainju	mani-kki	vā-r-**ōm**	
		we.NOM	five	hour-DAT	come-PRS-1PL	
		'We intend to come at five [o'clock].'				
	c.	nāṉ	nāḷaikki	kol	panu-v-**ēn**	
		I.NOM	tomorrow	call	make-FUT-1SG	
		'I'll definitely telephone tomorrow.'				

Bonta (2010) argues that the changes in the agreement paradigms of NFT are due to language contact between Tamil (which is a Dravidian language) and Sinhala (an Indo-Aryan language) in Sri Lanka as Sinhala also lacks verbal agreement, and has a distinct morpheme which when adjoined to a verb, conveys strong intention. Bonta's paper is a largely descriptive account of NFT however, and he does not make any concrete proposals about how NFT may differ structurally from other dialects.

It is worth mentioning here briefly, that cross-linguistically there is evidence that languages can use special markers to indicate a subject's involvement in contexts such as intentional action, and at least in the typological literature, this phenomenon is referred to as *egophoricity* (San Roque et al., 2018). San Roque et al. (2018, p. 2) write "…egophoricity is the grammaticalised encoding of the personal or privileged knowledge or involvement of a potential speaker (the primary knower) in a represented event or situation", and provide a broad overview of types of phenomena that fall under egophoric marking. This previous literature is however highly descriptive, and does not adopt a structural approach to explaining such systems of marking.

Returning now to the data at hand, the differences in (1), (2), and (3) raise a number of questions about the nature of agreement in Tamil. Why do the verbs in standard declarative clauses in NFT not show the same pattern of overt agreement as verbs in many other Tamil dialects like SIT? Why does the presence of agreement in the sentences in (3) change their meaning, if at least superficially, the verbs look the same as verbs in SIT clauses like those in (1)? Are there contexts in other dialects of Tamil in which agreement conveys additional meaning, perhaps relating to intentionality, or is the phenomenon in NFT explained solely in terms of language contact? The present work is an attempt at providing an answer to these questions. In particular, I propose that the use of agreement to convey intentionality is not exclusive to NFT, and is present in SIT as well. Moreover, I argue that whether or not agreement carries an additional semantic contribution relates to the nature and merge position of the φ-features in the clause, with the type of agreement present in (1) being the manifestation of uninterpretable unvalued φ-features merged at T, and the type in (3) being the manifestation of interpretable unvalued φ-features merged at C.

In providing a structural account of the agreement phenomenon described above, I follow the assumption that if a clause has a certain meaning or interpretation (without context), this meaning must be encoded in the syntax, since the semantic component of our language faculty can only compute meaning based on what input it receives from syntax. This is what Sheehan and Hinzen (2011) refer to when they write "Minimalism programmatically regards syntax as inherently linked with interpretive processes" (Sheehan & Hinzen 2011, p. 406). I aim to provide further evidence here in support of this strong relationship between syntax and semantics. Previous accounts that have adopted such an approach, such as *high-low attachment* accounts of the difference between productive/unproductive and compositional/non-compositional uses of certain morphemes (see De Belder et al., 2014; Harley, 2008), have already been highly fruitful.

In section 2, I summarise an account of complementiser agreement in Lubukusu, a Bantu language, by Diercks et al. (2020) which I base my proposal for Tamil on. In section 3, I describe my analysis of the phenomenon at hand, providing some additional examples of intra-dialectal variation in SIT to support my claims, and I provide a summary and conclusion in section 4.

2. Complementiser Agreement in Lubukusu

One rather comprehensive work that has looked at inter- and intra-language variation in the structure and semantics of agreement is by Diercks et al. (2020), based on the phenomenon of "upward" Agree in complementiser agreement in the Bantu language Lubukusu. In particular, complementisers of embedded clauses in Lubukusu can agree overtly with the structurally higher subjects of the matrix clauses as seen in (4) (Diercks, 2013, as cited in Diercks et al., 2020, p. 353, emphasis in the original), a pattern that is unlike complementiser agreement in Germanic languages for example, shown in (5) (Haegeman & van Koppen, 2012, as cited in Diercks et al., 2020, p. 348, emphasis in the original), where the agreement is with the φ-features of the embedded subject. Note that the numbers in the glosses indicate classifiers.

(4)	a.	**Ba-ba-ndu**	ba-bol-el-a	Alfredi	(Lubukusu)
		2-2-people	2SA-said-AP-FV	1Alfred	
		ba-li	a-kha-khil-e		
		2-that	1SA-FUT-conquer-FV		
		'The people told Alfred that he will win.'			
	b	**Alfredi**	ka-bol-el-a	ba-ba-ndu	
		1Alfred	1SA-said-AP-FV	2-2-person	
		a-li	ba-kha-khil-e		
		1-that	2SA-FUT-conquer-FV		
		'Alfred told the people that they will win.'			

(5)	a.	Ich	denk	**de-s**	**doow**	Marie	ontmoet-s	(Tegelen Dutch)
		I	think	that-2SG	you.2SG	Marie	meet-2SG	
		'I think that you will meet Marie.'						
	b.	Ich	denk	**det-Ø**	**geej**	Marie	ontmoet-e	
		I	think	that	you.PL	Marie	meet-PL	
		'I think that you will meet Marie.'						

The primary issue here is that while Germanic complementiser agreement may be explained by means of the conventional Agree operation where a probe looks downwards into its c-command domain and has its features valued by a goal which is structurally lower than it, the probe at the head of the CP in Lubukusu would apparently have to look upward to have its features valued by a structurally higher goal, an operation which is difficult to explain in light of what is known about the Agree operation. An upward probing Agree-based account would also not explain why the complementiser cannot agree with a matrix indirect object, even though this DP would be structurally closer to the probe, shown in example (6) below (Diercks, 2013, as cited in Diercks et al., 2020, p. 354, emphasis in the original).

(6) N-a-suubi-sya **Alfredi** n-di/ ***a-li** ba-keni

1SG.SA-PST-believe-CAUS 1Alfred 1SG-that/*1-that 2-guests

khe-be-ech-a.

PROG-2SA-come-FV

'I made Alfred believe that the guests are coming.'

Finally, the agreeing complementiser in Lubukusu makes a semantic contribution, unlike an agreeing complementiser in Germanic, indicating that the speaker believes the content of the embedded clause, shown in example (7) below (Diercks, 2013, as cited in Diercks et al., 2020, p. 358).

(7) Mosesi a-lom-ile ___ Sammy k-eb-ile chi-rupia.

1Moses 1SA-say-PRF that 1Sammy 1SA-steal-PRF 10-money

'Moses has said that Sammy stole the money.'

a. Moses saw the event, and the speaker believes him: **bali* [non-agreeing] /*ali* [agreeing]

b. Moses didn't see the event, but reported hearsay: *bali* [non-agreeing] /**ali* [agreeing]

c. Moses says he saw the event, but the speaker doubts him: *bali* [non-agreeing] /**ali* [agreeing]

Taken together, these facts about agreeing complementisers in Lubukusu lead Diercks et al. (2020) to postulate that the agreement on the complementiser is anaphoric in nature, in which case the apparently upward probing nature of the probe is less surprising.

Note that anaphors in languages such as English are also realised in a position that is structurally lower than the DPs that they agree with, as in John saw himself in the mirror. The φ-features on the head of the CP in Lubukusu, being anaphoric, are argued to be unvalued but interpretable, which explains why they make a semantic contribution. The precise mechanism of agreement for Lubukusu complementisers is thus as follows. The unvalued interpretable φ-features are first merged at Force0 separately from the complementiser, which is argued to be merged as the head of a Fin0 projection. The features are "patient" (Diercks et al., 2020, p. 361) and do not probe in their c-command domain yet, but wait until the subject of the matrix clause has been merged at the higher Spec-vP. The anaphoric φ-features then raise to a second Spec-vP of the matrix clause from where they value their features with the φ-features of the matrix subject, feature values which are inherited by the lower copy of the Force0 head. Finally, because Force0 has morphophonological requirements that it must be realised at a C0 position, the overt φ-features are spelled out on the complementiser of the embedded clause.

The final part of Diercks et al.'s (2020) analysis addresses the question of why the Agree operation of the anaphoric φ-features is "patient", and why they raise to the specifier of the vP to get their values. To answer both these questions, they appeal to the semantic and referential properties of phases as proposed by Sheehan and Hinzen (2011). According to Sheehan and Hinzen (2011), in addition to their roles as domains of syntactic computation, phases are an essential part of semantic computation as well, forming the basic "units of referential-deictic significance" (Sheehan & Hinzen, 2011, p. 407). More specifically, the DP phase is the domain of reference to objects, the vP phase is the domain of reference to events, and the CP phase is the domain of reference to propositions. Additionally, movement towards the edge of a phase (the phase head and its specifier) increases referential specificity. Thus, a DP without an overt D0 in English such as boy refers only to the kind boy, whereas a proper noun (which itself raises to D0) or a DP with a deictic demonstrative as a head such as that boy is maximally referential. Correspondingly for the vP phase, the nature of the phase edge determines if the vP simply establishes the existence of an event, whether it encodes an atelic or unbounded event, or a telic or bounded event (the maximally definite version of an event) (Diercks et al., 2020).

Given these properties of the vP phase and its edge, Diercks et al. (2020) argue that the raising of the anaphoric feature bundle to the Spec-vP has two functions. It allows the vP of the matrix clause to be maximally specific, since a truly specific and telic event must not only be bounded, but have specific participants.

This would be impossible if the vP had a referential feature bundle which was underspecified. It also allows the anaphoric φ-features to be valued since the phase edge is the site of referentiality, and the φ-features may probe into the vP to agree with the subject of the matrix clause. The raising of the anaphoric φ-features is thus mutually beneficial in some senses to the feature bundle itself, and to the matrix vP, to the extent that the movement allows both to receive the complete specification that the syntax and semantics require.

While the agreement phenomenon in Tamil presented in section 1 is not one of complementiser agreement, I propose in the following section that the account of Lubukusu provided by Diercks et al. (2020) may be adopted, albeit with some modifications, to account for the two types of agreement present in Tamil dialects.

3. Two Types of Agreement in Tamil

Before I outline my proposal for the agreement phenomena in NFT and SIT, I wish to introduce one additional data point. Given the limited availability of data from NFT, it is worth considering whether there are any situations in SIT in which the presence or absence of agreement has the same effect as in NFT. While agreement is always present in declarative clauses in SIT, its status in negative and modal clauses is more complicated. In fact, in the presence of most modals and the sentential negation morpheme *-illai* verbal agreement completely disappears, as illustrated in (8) below.

(8) a. Padma mara-ttil ēṟ-a-villai (SIT)

Padma.NOM tree-LOC climb-INF-NEG

'Padma will not climb/ is not climbing/did not climb the tree.'

b. Padma mara-ttil ēṟ-a-ṭṭum

Padma.NOM tree-LOC climb-INF-HORT[6]

'Let Padma climb the tree.'

c. Padma mara-ttil ēṟ-a vēṇṭum

Padma.NOM tree-LOC climb-INF should

'Padma should climb the tree.'

What is relevant here is that for none of the sentences in (8), including the modal clauses, can the action in question climb cannot have a subject oriented intentional meaning. The most common exception to this non-agreement pattern is that of the negative modal corresponding to the English won't. While in English this modal has largely lost its intentionality, now being used simply to denote the future tense (as in 'John won't come' does not necessarily mean 'John refuses/has refused to come'), the Tamil modal retains the intention-related meaning similar to refuses to. It is also one of the only modals which agrees overtly with the subject, as shown in (9).

(9) a. Padma marattil ēṟ-a māṭṭ-**āḷ** (SIT)

Padma.NOM tree-LOC climb-INF won't-3SG.F

'Padma won't (refuses to) climb the tree.'

b. nāṉ marattil ēṟ-a māṭṭ-**ēṉ**

I.NOM tree-LOC climb-INF won't-1SG

'I won't climb the tree.'

c. nī marattil ēṟ-a māṭṭ-**āy**

you.NOM tree-LOC climb-INF won't-2SG

'You won't climb the tree.'

Unlike in NFT where only first-person agreement carries intentionality, the modal māṭṭ- shows agreement with the subject in all persons, number, and genders. Considering this data in combination with the data from NFT then, we have evidence that both inter- and intra-dialectally, the presence of agreement in some circumstances can carry a meaning of intentionality.

I thus propose that the agreement morpheme that carries intentionality, like in Lubukusu, is a bundle of anaphoric unvalued interpretable φ-features that is merged at C0 (as shown in Figure 1) while the semantically "empty" agreement seen in SIT is a manifestation of the purely syntactic unvalued uninterpretable φ-features that are merged at T0 (as shown in Figure 2).

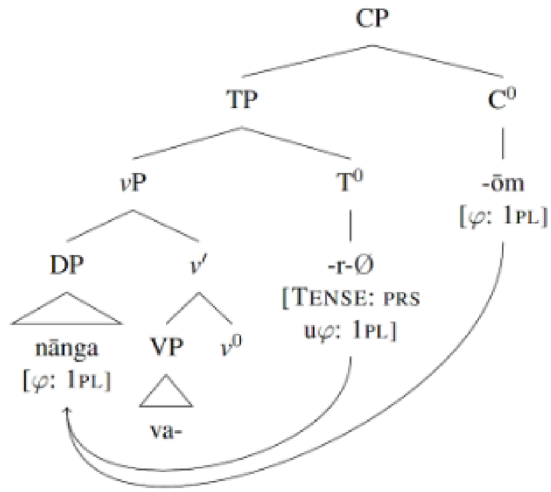

Figure 1: Derivation of the NFT sentence 'nāŋga vā-r-ōm' ("we intend to come").

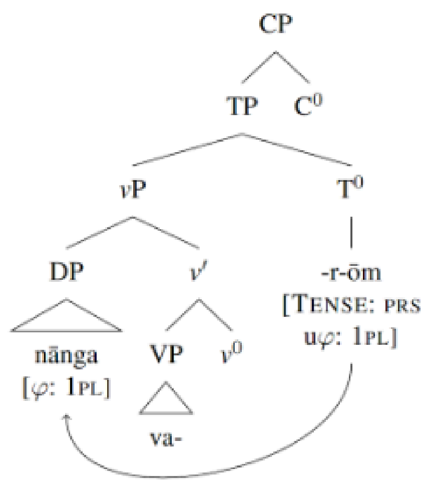

Figure 2: Derivation of the SIT sentence 'nāŋga vā-r-ōm' ("we are coming").

It is worth noting here, that according to Diercks et al. (2020) anaphoric φ-features must necessarily merge at a vP phase edge to satisfy the referentiality requirements of both the anaphoric φ-features, and the vP itself. This restriction would however pose a problem for the present scenario. First and foremost, the example of complementiser agreement in Lubukusu involved a biclausal structure, in which the anaphoric features raised from the edge of the embedded clause to a specifier of the vP of the matrix clause. The NFT examples, repeated here in (10), do not appear to be biclausal in any way however, though this is difficult to verify without judgements from a native speaker, which I could not obtain.

(10)	a.	nāṉ	avaŋga-ukku	kadai-cciy-en		(NFT)
		I.NOM	they-DAT	speak-PRS-1SG		
		'I intend to speak to him.'				
	b.	nāŋga	ainju	mani-kki	vā-r-ōm	
		we.NOM	five	hour-DAT	come-PRS-1PL	
		'We intend to come at five [o'clock].'				
	c.	nāṉ	nāḷaikki	kol	panu-v-ēn	
		I.NOM	tomorrow	call	make-FUT-1SG	
		'I'll definitely telephone tomorrow.'				

The SIT examples in (9) can however be shown to be monoclausal. In her account of Japanese causatives, Harley (2008) uses or-coordination to show that the productive causative in Japanese has biclausal properties. In particular, a single causative morpheme in Japanese can apply to two preceding verbs in a disjunction relationship. The negative modal in SIT fails this test, as shown in (11). The single modal negates both disjuncts, rather than retaining the properties of the or-coordinator, and permitting the disjunction of two negated verbs.

(11)	Padma	vīṭu	kaṭṭ-a	allatu	vāṅk-a	māṭṭ-āḷ
	Padma.NOM	house.ACC	build-INF	or	buy-INF	won't-3SG.F
	'Padma will neither build nor buy a house.' (*'Padma either won't buy, or won't build a house.')					

Harley (2008) also argues that a low VP adverb in the Japanese causative constructions can have scope over either the causing event or the caused event in a causative construction, whereas the same is not possible for the SIT negative modal. The adverb quickly in (12) can only refer to the climbing event, and not to the refusing event.

(12)	Padma	vēkamāka	mara-ttil	ēṟ-a	māṭṭ-āḷ	(SIT)
	Padma.NOM	quickly	tree-LOC	climb-INF	won't-3SG.F	
	'Padma refuses to quickly climb the tree.' (*'Padma quickly refuses to climb the tree')					

This modal structure also does not have multiple tense projections as it is not possible to have two different temporal adverbs within the same clause. However this test is less reliable, since if the embedded clause were not a complete CP, but for example, just a *v*P as in Japanese productive causatives, it would still fail the temporal adverb test.

I argue therefore that there is no evidence that the intentional agreement construction in Tamil is biclausal, which means that there is no higher *v*P where the anaphoric features may adjoin to. The alternative would be that the anaphoric features adjoin to the edge of the only *v*P in the clause, but given that Tamil is a head-final language with linear order of morphemes being verb-tense/mood-agreement, we would have to hypothesise that irrespective of the type of agreement morpheme, it must always linearise to the rightmost edge of the clause. It can also be argued that according to Diercks et al.'s (2020) ontology of *v*P referentiality, the requirement that anaphoric features adjoin to the *v*P is only present for fully specified telic predicates. Since all the examples of predicates from Tamil are of unrealised actions, they cannot be telic or maximally specific.

We must now either conclude that the φ-features in question are not anaphoric, or that there is another possible site where they may adjoin. If we accept Diercks et al.'s (2020) definition of anaphoric as referring to unvalued interpretable features, then it is clear that the intentionality bearing features in Tamil must be unvalued since they always match the φ-features of the subject, and must therefore be valued by an Agree operation. On the subject of interpretability, Hornstein et al. (2005) argue that [+interpretable] features are those which can take part in multiple feature checking operations, though this is difficult to verify in the Tamil example. If instead, we simply define interpretability as the property of being readable at LF (Logical Form) for semantic computation (Hornstein et al., 2005), then the φ-features in these Tamil constructions must be readable insofar as they contribute to the meaning of the utterance. If we proceed assuming that the φ-features truly are anaphoric then, they must adjoin to another site of referentiality in order fulfil their requirements.

Returning now to Sheehan and Hinzen's (2011) proposal regarding the semantic role of phase edges, we see that the CP phase edge may be a viable candidate to host the anaphoric φ-features. Sheehan and Hinzen (2011) propose that as with DPs and vPs, there is a threefold ontology of the referentiality of CPs as well.

Here, the least referential CPs (as shown in example (15)) are embedded clauses whose truth value is irrelevant to the truth value of the complete utterance, and which the speaker does not evaluate as true or false themselves. The next level of referentiality is embedded CPs that are factive or presuppositional in nature in that the speaker assumes them to be true (as shown in example (14)), whereas maximally referential CPs refer are assertions made by a speaker that importantly refer to a single extensional truth (as shown in example (13)). Examples of these three types are presented below (Sheehan & Hinzen 2011: 21-22).

Propositional

(13) a. [$_{CP}$ Superman is a superhero].

b. [$_{CP}$ Clark Kent is a superhero].

Factive

(14) He doesn't realise [$_{CP}$ that it's raining].

Indefinite

(15) a. Lois Lane thinks [$_{CP}$ that Clark Kent is a superhero].

b. Lois Lane thinks [$_{CP}$ that Superman is a superhero].

Note that according to Sheehan and Hinzen (2011) the nature of the phase edge is what determines the referentiality of the CP, though in English the distinction between edge types is somewhat less clear. In essence, (13) is maximally referential because there is covert V-to-C or T-to-C raising (as is clear in other Germanic languages), (14) is less referential because the complementiser is a pro-form C0 head which, and (15) is minimally referential because the complementiser is underspecified, and consequently, completely optional.

Focusing more specifically on the most definite CPs, Tamil clauses with an intentional reading can in a sense be thought of as "stronger" assertions than those without an intentional reading, especially since the assertion is about an unrealised event. Non-intentional assertions are evaluated by the speaker as being true, at least in the past and present tenses, by virtue of the fact that they already took place or are taking place.

An assertion about a future intentional action is being evaluated as 'true' before it has taken place, simply by virtue of the speaker's intention. I propose thus, that in a Tamil structure in which the C0 is overtly realised by some morpheme, the anaphoric φ-features, the clause receives an additional intentional interpretation. This also resolves the question of how the anaphoric φ-features can receive their referential interpretation because they are merged at a phase edge from where they can probe down into the clause and have their features valued by the φ-features of the subject. I wish to clarify here that I do not argue that SIT clauses with syntactic agreement (non-anaphoric φ-features merged at T0) are not assertions, but simply that those clauses have a phonologically empty C0 head. This is why the presence of an overt morpheme at C0 does not change the nature of the clause in terms of its propositional status, but simply adds a dimension of meaning, as would be expected following Sheehan and Hinzen's (2011) proposal that the nature of the phase edge can affect the nature of the semantics of the phase.

4. Conclusion

In this paper I have reviewed a variation phenomenon in Tamil regarding the usage of agreement morphology. In broad terms, my account begins to address egophoric phenomena in languages from a structural perspective. I have presented data that shows that the Tamil agreement morphology can be used both across dialects, and within a dialect, to convey intentionality under some specific circumstances. I have proposed that despite superficial similarities, Tamil actually possesses two types of agreement morphemes which are realisations of two different structures: uninterpretable unvalued φ-features merged at T0, and interpretable unvalued φ-features merged at C0.

Based on this account, the inter- and intra-dialectal variation stems from how flexible these two agreement types are. In particular, SIT allows both types of agreement to be realised overtly though it does not appear to use anaphoric φ-features in declarative clauses to convey intentionality. In NFT on the other hand, only anaphoric φ-features seem to be realised overtly, and can be used in declarative clauses as well. I have only provided evidence from two dialects to support this account, so for future research, it would be important to look for parallel phenomena in other Tamil dialects as well.

The precise reasons for the proposed variation are outside the scope of the present work, but the language contact between Tamil and Sinhala (Bonta, 2010) may provide an explanation. Thus, for example, a structural strategy already present in Tamil to convey intentionality in some constructions, may have been extended to other situations as well due to the influence of similar constructions in Sinhala.

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USING A BIINGUAL DUAL-PATH MODEL FOR EXPLORING SYNTACTIC MIXING OF SIMULTANEOUS BILINGUAL CHILDREN

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Abstract
While lexical code-switching (CS) in bilingualism language acquisition is widely discussed, syntactic CS, constrained and rare (Genesee, 2002; Vihman, 2018), remains an understudied topic (Poplack, 2008). Moreover, causes of preference for one language's syntax are still unclear (e.g. markedness vs pragmatic strategies). This research proposal investigates if syntactic CS is less frequent than lexical CS, if it follows patterns in its development, and if pragmatic intentions influence it when considering word order switching. We will compare a Bilingual Dual-path simulation (Tsoukala & al., 2021) against a corpus of the speech of simultaneous bilingual English–Turkish children in their extended intermediate language-acquisition phase, i.e. 2;5–3;5 years old. For both the corpus and the model, we predict less syntactic CS than lexical CS, but enough to detect patterns in its reduction. For simulated CS, because we control for markedness of word orders, equal training input, and because the model lacks pragmatic intentions, we predict equal syntactic CS for both languages. If the simulated syntactic CS reaches adult-like CS at different rates or in different patterns compared to the real data, we will show that pragmatic factors (e.g. parents' corrections, communicative preferences) influence it.
Keywords: Syntactic Code-switching, Bilingual, Language Acquisition, Corpus, Computational Model

1. Introduction

According to Poplack (2008), code-switching (henceforth CS) is mixing different languages within a single utterance. It involves using words or phrases from two or more languages without necessarily changing the interlocutor or the topic of the utterance. CS differs within groups of bilinguals, namely for second language learners and simultaneous bilingual children (Zirker, 2007). While for second language learners the L1 impacts the L2 more, for bilingual children, CS affects both languages (Adnyani & al., 2018).

In simultaneous bilingual children's spontaneous speech, lexical CS appears frequently. Many have studied lexical CS (Cantone, 2007; Meisel, 1994; Yow, 2018), as children mix the lexicons of acquiring languages for communicative purposes. For example, when simultaneous bilingual children do not know a word in the language in which they communicate, they use the equivalent in the other language. However, syntactic CS has been neglected (Poplack, 2008), as it appears less frequently, but also due to the lack of general theoretical models accounting for diverse aspects of bilingualism, such as ability, performance or developmental stages, as remarked by Grosjean (1998).

While lexical CS has been speculated to appear due to communication needs, it is still debated if internal (e.g. saliency) or external factors (e.g. dominant language, pragmatics) generate syntactic CS. Even more, as remarked by Li (2002), as experiments cannot control for individual factors, e.g. language dominance, onset of L2, or pragmatic intentions, separating the factors that are claimed to explain syntactic CS is even harder. Moreover, Genesee (2002) describes the acquisition challenge raised by CS: it is not random, the transfer is systematic and constrained by the target languages. Thus, CS emerges at specific levels and while certain rules are violated for one language, bilingual individuals do so in order to adapt to the rules of the other language. Additionally, it is known that children eventually regulate their use of CS to be rarer and more adult-like (see Vihman, 2018, for a broader discussion). In this respect, no previous articles explored if bilingual children go through stages or follow a pattern while adjusting their syntactic CS.

A syntactic CS phenomenon that has recently gained interest is word order switching in simultaneous bilingual children speaking languages with different dominant word orders (Adnyani & al., 2018; Vihman, 2018). The study of Adnyani & al. (2018) shows examples of cross-linguistic interaction of a German-Indonesian simultaneous bilingual child. While Indonesian is predominantly a SVO language, German is mostly used as a SOV language during the acquisition stage. For example, in (1) and (2), the child uses the lexicon of her dominant language (i.e. Indonesian) with the word order of her weaker language (i.e. German).

(1) kakak roti buat.
sister bread make
'Sister, prepare me some bread!' (Adnyani & al., 2018, p. 49)

(2) sandal pakai.

sandal wear

'Father, wear your shoes!' (Adnyani & al., 2018, p. 49)

Regarding bilingualism, computational models have proven useful to control individual differences variables (Li, 2002; Li, 2013). For instance, previous studies such as Monner et al. (2012, as cited in Li, 2013) used computational models to either control for the effect of different memory capacities or language exposure levels in L2 learning. Given such benefits, the current research proposal offers a solution to the factors influencing syntactic CS through a computational model.

The model of this study aims to simulate syntactic CS patterns in simultaneous bilingual children of English and Turkish, two languages with different word order. The performance of the model will be evaluated against a corpus by statistical comparison. Thus, this research will be divided into two main stages.

The first stage will concern data collection for the children's corpus study: a lengthier corpus is needed as many have remarked that bilingual corpora containing CS are scarce (Doğruöz & al., 2023; Lee & Li, 2020). The second stage will involve performing the computational simulation by training a model on data equivalent to speech heard by bilingual children. Overall, through the comparison of the model with real data, we will answer the following research questions: is word order CS more frequent than lexical CS? Does syntactic CS show any patterns as it decreases to be adult-like? Does pragmatic intention play a role in syntactic CS?

By controlling for equal input, and by choosing two salient equal languages for word order, we will rule out the external factor of language dominance, and the internal factor of word order saliency. Thus, we will test if the remaining external factor, pragmatic intention, is responsible for syntactic CS, by training a model that lacks pragmatic intention on similar bilingual data to that of children.

With regards to these research questions, our first hypothesis is that mixing at the syntactic level is less common, while our second hypothesis is that syntactic CS is not random. Our third hypothesis is that a computational model, that lacks external pragmatic factors, can predict syntactic CS.

This research proposal is structured as follows: section 2 is a literature review of theoretical and computational accounts of CS, section 3.1 describes the participants selection, the data collection and processing, section 3.2 outlines the computational model, section 4 details expected results, and section 5 deals with limitations and discussions.

2. Literature Review

Given the double-sided nature of our research, this literature review discusses, firstly, the existence of syntactic structure mixing in the spontaneous speech of bilingual children. During this first section, internal and external factors of CS will be discussed. Both factors are important to follow given our study will investigate which ones are more likely to influence syntactic CS. The power of the model to simulate these factors will be discussed in sections 4 and 5.1. The second section concerns an evaluation of previous computational models used in studying CS.

2.1 Code-switching

Simultaneous bilingualism is defined as the acquisition of two or more languages, from a very young age, and at the same time (Bullock & Toribio, 2012; Myers-Scotton, 2006). Though debated previously, it is broadly accepted that simultaneous bilingual children acquire the two systems independently, the acquisition being the product of separated developments (for a broader discussion see Cantone, 2007; Genesee, 2002), due to evidence from preferential use of a language depending on the addressee (Adnyani & al., 2018; Genesee, 2002). However, despite separated developments, studies such as that of Hauser-Grüdl (2010) show that there are cross-linguistic influences (henceforth CLI) between them, though causes and domains of CLI are still debated. While some authors argue that external factors are the source of CLI, others defend the role of internal factors on CLI.

External factors are defined as being the influence of the dominant language (Adnyani & al, 2018). Indeed, even if children are bilingual, they still have one dominant language, namely the most used in their environment. For the remaining factor, the saliency of linguistic features is the foremost internal factor.

For example, in the study by Adnyani & al. (2018), a child was acquiring Indonesian and German, and though Indonesian was the most dominant language, the German word order is more salient because German, for adult speakers, is a V2 language and does not accept any other order, except for embedded clauses in which the verb must be at the end. Though Indonesian has a preference for SVO order, it can accept other orders, while German cannot. Using the examples of Adnyani & al. (2018), Indonesian can have an SVO order in (3), and a VOS in (4), while German can only have the auxiliary in second position and the verb at the end, as in (5).

(3) Aku beli karpet.

I buy carpet

'I bought a carpet.' (see Adnyani & al., 2018, p. 37)

(4) Beli karpet aku.

Buy carpet I

'I bought a carpet.' (see Adnyani & al., 2018, p. 37)

(5) Ich habe einen Teppich gekauft.

I AUX a carpet bought

'I bought a carpet.'

Even though German is used as a SOV language during the acquisition phase by children, the markedness of German word order (ie. not accepting different word orders) is already integrated by the child. Thus, the child will consider German as a SOV language that cannot accept other orders until a certain phase of acquisition in which they will use German as a V2 language, but they will never, like in Indonesian, use different word orders.

Thus, the prominence markedness of word order in German overlapped with the dominant language of the studied child. In the aforementioned study, the lexicon of the stronger language was used with the structure of the weaker language.

Adnyani & al. (2018) posit that both languages participate in CLI, but not equally, and that internal and external factors both play a role in it. Even certain linguistic domains, such as temporal markers, can be more affected by internal or external factors. One of their hypotheses is that simultaneous bilingual children can adapt the structure of their sentences according to their interlocutor, as Vihman (2018) talks about "socio-pragmatic motivation". Thus, syntactic switching would occur at the syntax-pragmatic interface.

There are several theories of linguistic CS such as the Trigger Chain Theory (Lehmann, 1971) or the Universal Consistency Hypothesis (Hawkins, 1979). The former has been partly refuted by Luján & al. (1984). Their study demonstrates that CS does not have to be initiated by a violation of a synchronic universal. They showed an early stage of acquisition, in which bilingual children borrow the word order of their dominant language, then an extended intermediate stage of approximately five years, in which the variation among ordering takes place, and, finally, the full acquisition stage.

2.2 Computational Models

For Li and Xu (2022), a computational model is fit due to its "validity" (i.e. is a likely representation of human behavior), "contact with real language" (i.e. the training data has to be as complex and similar to real language), "interpretability" (i.e. capability to explain and further provide data for other studies) and "predictive power" (i.e. prediction of linguistic phenomena).

Few studied CS in computational linguistics (Tsoukala & al., 2019; Tsoukala & al., 2021; Xu & al., 2021) as it is still an open problem in computational linguistics, according to Doğruöz & al. (2023). Xu & al. (2021) represented adult bilingual corpora by semantic networks to study if bilingual lexicons are stored separately and if switched words have more semantically related neighbors (i.e. neighbors tightly clustered together) than their replaced counterparts. Their results showed that bilinguals have different semantic networks for each lexicon, and that switched words have less clustered neighbors, being easier to retrieve. Though their study proves useful for research on CS as it controls word frequency, it neglects acquisition of CS and, implicitly, syntactic CS. Overall, their method is unsuitable for language acquisition research as it represents organization of words, rather than developmental stages of the algorithm.

Tsoukala & al. (2019, 2021) used the Bilingual Dual-path model (henceforth BDPM) to show that, for English and Spanish, CS appears without exposure to input with CS. A dual-path model is composed of a recurrent neural network for learning syntactic structure and a semantic stream component for learning semantic information (e.g. thematic roles, event-related semantics). Production is done word-by-word, the highest activated node that represents a word being generated. Word-by-word generation is also a consequence of using a recurrent neural network for the model itself, given such networks predict and generate most probable next words. Their model adds, to the components of the dual-path model of Chang (2002), a language control component that chooses the target language for a message.

Thus, while they use nodes to represent target languages within the network, their language control component makes CS possible, as each new production of a word can activate the other target language. This means that as a model can generate new words based on probabilities, it does also have a separate node that when activated, produces the next word in another language. Similarly, CS also appears in the output of a trained dual-path model to simulate L2, in Janciauskas and Chang (2017).

In the CS produced in Tsoukala & al. (2019), no syntactic CS is reported. However, the model follows grammatical constraints when code-switching from English to Spanish: to generate grammatical output in Spanish, the model adds prepositions, despite them not being in the original input.

BDPM was used in Tsoukala & al. (2021) for both balanced and non-balanced bilinguals models. While the former receives equal inputs for both languages, for the latter, the start of input for L2 is delayed. The results, which measured frequency, type and point of occurrence of CS, were compared with real corpora. The simulations showed that, when starting, non-balanced simulated subjects produce few L2 correct sentences that most code-switch into L1 (almost 90%). With time, the more the model subjects produce correct sentences, the less they code-switch, i.e. around 4% of CS when L1 is Spanish and 5% when L1 is English. Similarly, children also code-switch less with time, as noted previously. Contrastively, at the end of training, the balanced bilingual subject models code-switch more frequently than the non-balanced ones. A similar remark was made by Janciauskas and Chang (2017), as late-learner models of L2 (i.e. non-balanced ones) code-switch less. The model of Tsoukala & al. (2021) presents similar patterns with real corpora, showing more frequent CS for nouns than for verbs. However, the percentage of CS for nouns is shrinked: amounting to 1% in simulated CS, comparatively to 30% in the real-corpus. Moreover, the models prefer inserting Spanish determiners, pattern unobserved in real corpora.

Both studies of Tsoukala & al. (2017; 2021) provide important insight into the emergence of CS, while also predicting real patterns of CS for nouns. However, the studies have limitations. First, their models do not explain why real CS takes place, nor are they used explicitly within a linguistic framework. The training datasets are low in similarity to real language, as they contain a maximum of 200 words and few characteristics of time and aspect, i.e. present and past, respectively simple, progressive, and perfect. Even more, the training dataset contained no CS. Given the fact that bilingual children most probably hear CS, training a model without CS is uninterpretable for the field of language acquisition.

Furthermore, the choice to compare the simulation results with adult corpora is unjustified. As the models had to learn everything from scratch, they differ from adults in the amount of exposure to language input. It would have been more accurate to compare the results with those of a corpus of children bilinguals. Such unjustified comparison can explain why the model presented only 1% of CS for the ratio of nouns and verbs: as children differ from adults in their length of utterances, more words uttered make possible more CS in the adult corpus. Even more, the unusual insertion of Spanish determiners within the models might be an unattested developmental syntactic CS stage of children. Since the models were compared with adult corpora, we cannot tell if, in their development, children present a similar pattern. Consequently, BDPM, as used by Tsoukala & al. (2017; Tsoukala & al., 2021), has low interpretability as it does not explain determiner insertion, or appearance of CS. Lastly, both studies neglected the developmental stages of CS.

Overall, CS is an understudied phenomena in computational modeling with many unanswered questions. As the studies reviewed provided answers, none of them concerned exclusively the factors that influence syntactic CS or its potential acquisition stages.

3. Methodology

3.1 Investigation on simultaneous bilingual children

3.1.1 Participants and linguistic environment

In choosing participants, bilingual children speaking standard British English and Turkish will be opted for, due to their languages having different word order, but similar saliency: namely English has SVO and Turkish SOV.

Children produce syntactic mixing in their extended intermediate stage of acquisition. However, the extended phase of acquisition is slightly different for each language and while monolingual English children have fully acquired SVO order at 3;9 years old, as showed by Matthews & al. (2005), Turkish monolingual children know head-directionality around 4;0 or 5;0 years old, according to Batman-Ratyosyan (2003). Thus, we will sample an age range common to the extended intermediate stage of both languages: between 2;5 and 3;5 years old, i.e. before they fully acquire the word order. All children will be recorded at different developmental stages, as they grow, making the corpus a longitudinal research.

The participants should be the children of a first-generation Turkish immigrant and a native standard British English speaker living in England. Thus, they should speak Turkish and standard British English at home and English in preschool.

Thereby we exclude a potential effect of external contextual separation of the two languages, by choosing participants with similar environments and external factors. We will make sure that the participants have similar biographical data as mentioned in Grosjean (1998), e.g. age, sex, socio-economic status. To avoid a gender variable interaction, we will choose half the participants male, and half female.

Lastly, to compare the model's results to that of real corpora, a within-subject t-test and a variance test will be used. Statistic calculations showed that for our study, in order to get a p-value of 0.005, we need at least 88 participants.

Overall, CS is an understudied phenomena in computational modeling with many unanswered questions. As the studies reviewed provided answers, none of them concerned exclusively the factors that influence syntactic CS or its potential acquisition stages.

3.1.2 Data collection, transcription and analysis

We will record spontaneous conversations, in natural settings, during various daily activities, some in which the children studied speak English, and some in which they speak Turkish. As syntactic CS might be more present within a context due to certain external factors, thus we avoid a potential randomness effect by providing different conversational contexts. We will use Deuchar & al. (2014) for the methodology regarding the recording equipment and procedure, the transcription method, e.g. language marking and glossing, while also taking back their ethical considerations. The parents will be informed about the purpose of the study.

Considering examples (3) and (4), we expect to see English lexicon used with a SOV word order, as in (6), and/or Turkish lexicon used with a SVO order, as in (7).

(6) The cat my crackers eats.
'The cat eats my crackers.'

(7) kedi yer krakerlerimi.
cat eats crackers-my
'The cat eats my crackers.'

3.2 Training of the model

The computational model we will use is BDPM, given its previous successful simulated accounts of CS. To account for variability within speakers, we will simulate 88 model subjects, similarly to Chang (2009). To make the training data more similar to that of real language, we will use child-directed speech from adult monolingual corpora, namely from the Turkish National Corpus (TNC, 2023) and of CHILDES (MacWhinney, 2000). For both corpora we will select a number of random parent sentences for Turkish and British English. Unlike previous computational studies, we will add to the two monolingual corpora CS sentences from the bilingual CS corpus collected by Yirmibeşoğlu and Eryiğit (2018). Similarly to Chang (2009), we will use a sentence generator to produce, from the corpora, 88 sets of 40,000 adult-like sentences for each language. Each set will be fed to a different model subject. For both languages, the input will be equal and the training will be done incrementally. After 5000 training sentences, the models will be tested on production performance: they will be required to predict sentences. Unlike previous studies, the developmental stages of the simulated models, i.e. the test performance, will be compared to the real data observed. Lastly, according to Yang (2002), the dual-path model avoids overfitting and continuously improves during the training set. We expect similar behavior of BDPM, as it only adds a language control component.

4. Predictions

Firstly, we predict less frequent syntactic CS than lexical CS in both the corpus and the model. As the syntactic level is a fundamental support of other linguistic patterns, it needs to be operational and acquired very early in the acquisition process, in order to support the semantical and the phonological levels.

Secondly, we predict that a pattern of switching will be present in both the corpus and the model. Given previous studies, we know that computational models code-switch less with time, thus we also predict decreasing rates of syntactic CS for the subject models.

Thirdly, we predict equal syntactic CS in both simulated languages, due to the lack of remaining factors influencing the model to choose one syntactic word order over the other. As we will control for two factors speculated to influence syntactic CS: the dominant language and saliency, the only potential remaining factor is pragmatic strategies, an external factor our model does not simulate.

Lastly, we expect the model to mimic real data in terms of amount and decreasing patterns of CS.

5. Discussion and limitations

5.1 Discussion

The aforementioned predictions would show that syntactic CS, less frequent than lexical CS, is not random or influenced by pragmatic factors. If the results do not have an equal amount of syntactic CS, this would mean that external factors, e.g. pragmatic or community practices, influence syntactic CS. Moreover, if the model does not achieve adult-like CS by the end of training, it would mean that pragmatic factors and/or corrections play a role in the decrease of syntactic CS. Over and above, if syntactic CS of the model decreases at different rates than that of real corpora, depending if the model's adjustment rates are slower or faster, it would mean that external factors can fasten or hinder syntactic CS adjustment.

Overall, our model will have high interpretability by offering insights for future research regarding potential developmental stages of syntactic CS and new hypotheses for syntactic CS. Concerning the rates of decreasing syntactic CS, by observing the developmental stages of syntactic CS we might add, if observed, other stages to the early, extended intermediate, and fully acquisition stages. Even more, if we observe differences in the amount of syntactic CS, future research should concern proposing a new hypothesis for syntactic CS, where elicited production tasks will be designed to check for the new proposed factors.

5.2 Limitations

Firstly, the collection of the real data will be limited by impossibility to approximate or control for the amount of language input children hear. Thus, due to limitations of uncontrollable individual differences, our models will not be able to replicate exactly the amount of input received by children. However, we will use statistical tests on variance to compare how different are the distributions of individual participants and simulated models.

Secondly, the presupposed factors that influence syntactic CS will be limited to language dominance, saliency or pragmatics. While the current model considers factors currently discussed in the literature for syntactic CS, it does not account for new or understudied ones. However, though not exploratory, our study will have high validity in terms of work within linguistic frameworks.

Lastly, some aspects of BDPM are incompatible with learnability. Firstly, the model learns through feed-back, i.e. supervised learning. As it contradicts lack of negative evidence in language acquisition, this technique renders low linguistic validity. Future studies should consider unsupervised learning in their training. Secondly, BDPM assumes no prior language knowledge, ruling out, by default, innateness.

A pre-trained model would be more suitable for innateness theories. Though the training data comes closer to complex syntactico-semantic language patterns, the CS sentences from Yirmibeşoğlu and Eryiğit (2018) are collected from digital media. Future studies should concern building a corpus of CS child-directed speech for English and Turkish. Over and above, the model will not be able to access nonverbal language information, e.g. hyper-articulation of language in child-directed speech (Fernald and Simons, 1984), and cannot investigate their effects on syntactic CS. To account for this type of complexity, future models should add new components (layers) concerning cues for pragmatic intention, community practices or tone, inter alia. Furthermore, future models should consider languages with different saliencies for word order and their impact on syntactic CS.

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