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RESEARCH

Tracking the early stages of child and adult comprehension of L2 morphosyntax: A pilot study

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A number of studies in SLA and developmental psychology have shown that both children and adults can acquire nonnative word orders after a relatively short amount of exposure to a miniature language with natural-syntax characteristics in implicit instruction conditions. Although there is some evidence that in these conditions adult L2 learning can extend to morphemes (e.g., gender, case), little attention has been given to child-learning of morphology to date. In this pilot study six nine-year-olds and eight adults (all L1 English monolinguals) were exposed over three consecutive days to auditory sentence stimuli in BrocantoJ, a miniature language mirroring the word order and morphology of Japanese, in the context of a computer game similar to chess. Accuracy in performing a game move after hearing a sentence stimulus that described it, and accuracy in a forced-choice task, were used as measures of overall language comprehension and comprehension of the relationship between an argument's syntactic realization and its thematic function (linking). The data showed that both groups performed significantly above chance overall and on linking rules. However, adults performed significantly better than children in the first two sessions ($p < 0.01$), though the gap disappeared by the third day. Also, initial evidence showed that, at least for a subset of the sentence stimuli, both children and adults were successfully relying exclusively on case marking to interpret NP thematic functions.

Keywords: Age differences; L2 morphosyntax; Linking rules; Rate of learning; Implicit instruction; Implicit language knowledge

1. Introduction

In the last twenty-five years a growing body of research has investigated the nature of learners' early mental representations of novel miniature languages with natural-language characteristics. Although artificial languages (ALs) have been used to study a variety of linguistic properties, a substantial amount of research in the field has developed in the area of morphosyntax. Overall, these studies found evidence that adults can successfully learn novel morphosyntactic forms as well as form-meaning mappings after a relatively short amount of exposure to the new language (less than an hour to a few days), but not much research to date has investigated the ability of younger learners to learn morphology or establish form-meaning relationships as a result of learning novel linguistic forms. Similarly, it is not clear to which extent adult learning and child learning of a novel linguistic system differ when the two age groups are matched for instruction conditions.

Miniature ALs built to resemble natural-language syntax[1] have been used extensively in SLA, psycholinguistic and neurolinguistic research and offer two main advantages compared to natural languages. First, simplified miniature systems can be acquired faster as learners can reach levels of high proficiency within a short period of training. Secondly, they allow for precise control over a number of variables; phonological and morphosyntactic differences with the learner's native language, age of first exposure (the language is novel for all participants), and the conditions in which the language is learned.

A characteristic typical of many adult studies in this strand of research is the interest in the role played by the type of instruction provided (implicit/explicit) or/and the type of language knowledge (implicit/explicit) developed by the learner during the exposure to the language. According to current definitions in SLA, "implicit instruction is directed at enabling learners to infer rules without awareness" (Ellis, 2009, p. 16), whilst in explicit instruction "learners are encouraged to develop metalinguistic awareness of the rule" (Ellis, 2009, p. 17). When the dichotomy is applied to define language knowledge, implicit language knowledge refers to knowledge held by the speaker/learner without awareness of the structural patterns of the language, whilst language knowledge that is explicit requires at least some awareness of the formal aspects and regularities of the language.

Many studies in this area of research have assessed the learners' ability to verbalize the content of linguistic knowledge acquired as a result of exposure to a new

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language. In particular, it is widely assumed that the ability of the speaker/learner to verbalize language knowledge implies the availability of some form of explicit mental representation of the language properties. On the other hand, lack of explicit verbalization of language rules could depend on the learner's individual inability to verbalize explicit knowledge and does not necessarily indicate that the relevant language knowledge is implicit.

Adult language studies that have elucidated how different types of instruction conditions modulate language learning, as well as what type of knowledge emerges as a result of language learning, have mostly found that explicit instruction conditions[2] (that are mainly thought to support explicit learning processes) are overall significantly related to more robust learning gains (DeGraaf, 1997; DeKeyser, 1995; see Spada & Tomita, 2010 for a review) and that successful adult language learning tends to be associated to the availability of explicit language knowledge (Grey, Williams & Rebuschat, 2015; Rebuschat & Williams, 2012). By contrast only a few child studies to date have investigated the implicit/explicit aspects of language instruction or language knowledge representation, and even less have done so using a miniature language paradigm (but see Ferman & Karni, 2010; Lichtman, 2012). The gap in this area of research is especially evident in consideration of the hypothesis widely adopted in SLA research that children mainly rely on implicit strategies, not only to acquire their native language but also to learn second languages (Bley-Vroman, 1990; DeKeyser & Larson-Hall, 2005; Muñoz, 2006; and Lichtman, 2016 for recent discussion).

The main aim of the present pilot study is to investigate to what extent eight- to nine-year-old children and adults differ in the comprehension of a miniature language similar to Japanese to which they were exposed in implicit instruction conditions[3] over a period of three days. Specifically, the study investigates overall sentence comprehension and learning of the linking rules between syntactic positions and thematic functions, as well as between case marking and thematic functions. Although the study will not include a discussion of the age factor in relation to the type of language knowledge representation at this stage, it proposes a paradigm in which this investigation can be pursued in future research.

2. Literature Review

2.1 Adult studies adopting miniature-language paradigms

The literature on L2 learning of morphosyntax has consistently shown that adults can acquire nonnative word orders (including form-meaning mappings) through relative brief exposure to an AL, although mixed results have been found for inflectional morphology (Boyd, Gottschalk & Goldberg, 2009; DeGraaf, 1997; DeKeyser, 1995; Friederici, Steinhauer & Pfeifer, 2002; Grey, Williams & Rebuschat, 2014; Morgan-Short, 2007; Morgan-Short, Sanz, Steinhauer & Ullman, 2010; Rebuschat & Williams, 2012; Rogers, Révész & Rebuschat, 2015; Williams & Kuribara, 2008).

Williams and Kuribara (2008) used Japlish, a semi-artificial language with English lexis and Japanese morphosyntax (word order and case) in a single-session design. They tested 41 L1 English university students on the acquisition of syntactic scrambling, after 25 of them were trained in the language in incidental conditions by means of a plausibility judgment task and using 194 bimodal (visual and aural) sentence stimuli. In a receptive GJT administered using the same modality they found that the exposure group showed significantly higher accuracy in judging the grammaticality of scrambling compared to the control group both on trained and novel items.

Grey, Williams and Rebuschat (2014) used Japlish to further investigate adult L2 learning of word order and case morphology. In the first of two sessions, they trained two groups of L1 English learners of Spanish, one with high and the other with low L2 proficiency, using an aural plausibility judgment task (20 minutes, 128 items). Immediately after training, and again after two weeks, they tested receptive performance in word order with an aural acceptability judgment task, and the acquisition of the relationship between thematic structure and case marking by means of a picture-matching task (aural sentence stimuli). At immediate posttest the tests revealed that, overall, learners performed significantly above chance on word order but not on case marking. However, accuracy on case marking improved at posttest, becoming statistically significant. The posttest also revealed significant positive relationships between proficiency in the AL and the participants' ability to verbalize the language rules, as well as between proficiency in the AL and proficiency in Spanish.

Morgan-Short (2007) trained 42 L1 English adults in the language Brocanto2, in the context of a computer game similar to chess over three sessions, a maximum of five days apart (for a description of vocabulary training and the gaming environment see the Methods section). The language, based on Brocanto (Frederici, Steinhauer & Pfeifer, 2002), mirrors the gender morphology of modern Romance languages and displays SOV word order. In the training phase of each session (13 minutes) participants first listened to a set of sentence exemplars while watching the corresponding game constellations on screen (33 exemplars and metalinguistic information in the explicit condition, and 127 exemplars in the implicit condition). After exposure, participants practiced the game in a total of 44 alternating comprehension and production blocks (20 items per block) distributed across the sessions, whereby they listened to a sentence in Brocanto and had to perform the corresponding move (comprehension, see Methods section), or they had to utter a Brocanto sentence to describe a game move they had just watched on screen (production). The behavioral measures of language learning included two aural GJTs (one administered when participants had reached low proficiency and the other at the end of practice), plus one speeded aural GJT, a written GJT, and a free production task administered at the end of practice. Accuracy in the GJT at low levels of proficiency showed that participants in the explicit condition

outperformed participants in the implicit condition, but only in the learning of gender agreement structures (noun/article and noun/adjective agreement). At the end of training no significant differences were found between conditions in any of the measures.

In a follow-up study Morgan-Short, Sanz, Steinhauer and Ullman (2010) investigated specifically the acquisition of gender agreement and trained 30 L1 English adults in Brocanto2 using a similar methodology. In that case the study found that although participants in both the implicit and the explicit condition showed significant gains between a GJT test administered at low levels of proficiency and a GJT administered at the end of training, only the implicit group improved significantly on noun-adjective agreement (p. 171).

2.2 Child studies adopting miniature-language paradigms

The main body of literature that has investigated how children learn nonnative sentence patterns and construction-meaning relationships using exposure to semi-artificial languages in laboratory conditions comes from developmental psychology (Boyd & Goldberg, 2012; Braine et al., 1990; Brooks, Braine, Catalano, Brody & Sudhalter, 1993; Casenhiser & Goldberg, 2005; Hudson, Kam & Newton, 2005, 2009; MacWhinney, 1983; Wonnacott, Boyd, Thompson & Goldberg, 2012). A common feature of AL studies looking at morphosyntactic learning in children has been an interest in the role of input, both in terms of frequency effects as well as the way input is structured.

Casenhiser and Goldberg (2005, Experiment 1) investigated how 51 six-year-olds learnt a novel verb-final word order associated with five novel verb forms. The verbs also presented a novel meaning, whereby an entity (NP1) would appear in a location identified by NP2 in ways specified by the verb, e.g., sailing, dropping down, rising, rolling, etc. An exposure phase of the duration of three minutes included 16 video clips paired with audio descriptions (a control group watched the videos with no sound). The study compared two experimental groups, one exposed to an item set where one verb was four times more frequent than the others and one where the frequency of verb tokens was balanced, and a control group. The results of a forced-choice comprehension task, where participants had to match an aural sentence stimulus to the correct video (out of two), showed that both experimental groups performed significantly better than controls in learning the construction and that the skewed-input condition significantly outperformed the balanced-input condition.

More recently, Boyd and Goldberg (2012) adopted a similar exposure and testing methodology in relation to the comprehension of a novel NP1-NP2-V structure, where NP1 was an entity moving towards a goal (NP2) in ways specified by the verb. The study compared 18 five-year-olds, 18 seven-year-olds and 18 undergraduates and tested not only the overall learning of the novel construction (non-linking trials), but also the ability to learn the linking rules relating an NP's thematic function to a specific syntactic position in the sentence (linking trials). For non-linking trials the forced-choice task found significant group differences, with adults outperforming children, and seven-year-olds outperforming five-year-olds. In the linking trials no significant differences were found between adults and older children, whilst both groups significantly outperformed smaller children, who were at chance.

Wonnacott, Boyd, Thompson and Goldberg (2012, Experiment 1) trained 42 L1 English five-year-olds, in a miniature language with a novel word order (V–NP1–NP2) associated to a novel approach semantics (NP2 approaches NP1 in a way specified by the verb), over three sessions. They manipulated input in the exposure (one-verb vs. four-verbs sets) and item familiarity in the testing tasks, repeated at the end of sessions 1 and 3. In the exposure (one block on session 1 and 3, and two blocks on session 2) the experimenter read aloud 16 sentences each followed by a demonstration of the relevant event using toy animals. The three testing tasks had four trials each – general comprehension trials and trials designed to test argument linking – and included acting out of the event semantics using toy animals after an aural stimulus, production after a visual stimulus (event enacted by the researcher) and a forced-choice task (selecting a video matching with an aural sentence stimulus out of two – linking trials only). Except for the forced-choice task, where children were at chance, the results of the other two tasks showed that there was an improvement of the understanding of the linking rules over time as well as a significant learning effect for the construction as a whole.

One point that has been scarcely addressed in child studies, and deserves more investigation, is the role of morphology in conveying semantic information in sentences displaying a higher level of morphosyntactic complexity. In natural languages case morphology has a function similar to word order in the encoding of thematic relationships, although the individual contributions of these two strategies to the thematic interpretation of noun phrases by learners of a novel L2 are not yet well understood. Although a number of studies have shown that children can learn the relationship between affixes and their meanings after relatively brief exposure to lexical exemplars (Braine et al., 1990; Brooks et al., 1993; MacWhinney, 1983), we have no evidence as yet that the ability to relate morphemes to an associated meaning extends to arguments in full sentences. Also, acquisition of the linking rules between syntactic position and thematic function has been mainly investigated in sentences with bare nouns and no determiners or verb modifiers, but the question whether exposure to an AL in implicit conditions would still result in learning of these relationships in sentences displaying a richer phrase structure remains open.

A further point to consider is the comparison of child and adult rate of learning in instructed contexts, a question that has been central to instructed SLA in recent years (García Mayo & Lecumberri, 2003; Muñoz, 2006). In general, these studies found that after extended periods of classroom instruction (one to three years), adults

display higher rates of learning compared to children, although this difference is mitigated in the case of auditory receptive skills (García, Mayo & Lecumberri, 2003, p. 171). To the best of my knowledge the issue of whether rate of learning is age-dependent has not been addressed in laboratory AL studies employing a fully productive miniature language (see Ferman & Karni, 2010, for a study investigating differences in rate of learning of an isolated morphological rule). The distinctive advantage AL laboratory studies offer in this area of investigation is to provide an environment where instruction can be controlled, a situation difficult to achieve in classroom contexts, where teaching methods and materials can vary substantially depending on the age group. In view of the literature review, the research questions of the present study were formulated as follows:

RQ1: To what extent do children and adults differ in the rate of overall comprehension of a new AL in the early stages of learning?

RQ2: To what extent do children and adults differ in the rate of comprehension of the linking rules relating syntactic position and thematic function for argument noun phrases?

RQ3: Is there any evidence that children and adults learn the relationship between a case marker and the thematic function of the associated noun phrase?

3. Methods

3.1 Participants

Six children (M = 9.5; SD = 0.7) and eight adults (M = 29; SD = 8.9), all English monolinguals, were selected for this pilot study. All phases of the experiment complied with ethical procedures approved by the host institution and informed written consent was obtained from adults and from the children's parents. The children were recruited by advertising the study to parents through schools and libraries in the Greater Manchester area, whilst the adults were recruited among students on campus and individuals who had previously expressed an interest in participating in a language learning study. All participants received £15 for their participation.

3.2 The miniature language

The artificial language, called BrocantoJ, is a modification of Brocanto2 (Morgan-Short, 2007, and subsequent studies), mirrors Japanese morphosyntax but has English phonotactics. BrocantoJ has 12 vocabulary items: three obligatorily transitive verbs (the moves *nim*, 'capture', *praz*, 'swap with', and *yab*, 'release'), one intransitive verb (the move *klin*, 'move'), four nouns indicating the token symbols (*pleck, blom*, *neep,* and *vode*), two adjectives for the tokens' shapes (*neimo*, 'square', and *troise*, 'round'), and two adverbs to indicate the possible directions of movement (*zayma*, 'horizontally', and *noyka*, 'vertically'). Similar to Japanese, BrocantoJ is uniformly head-final and has two postpositional case markers (*li* for nominative and *lu* for accusative). The basic word order of the language is Subject-Object-Adverb-Verb, with no determiners and with adjectives preceding nouns inside the nominal phrase. As the learners were L1 English monolinguals, aspects of the language that were novel to them included sentence word order (e.g., verb and adverb position), case morphology, and the possibility of omitting subjects if the information can be inferred from the context. The following are examples of SV intransitive sentences, SOV transitive sentences with expressed subjects, and OV transitive sentences with null subjects. Each sentence relates to the corresponding move in **Figure 1**.

(1) *Neimo blom li noyka klin* **(SV)**
Square blom NOM vertically move
'The square blom token moves vertically.'

(2) *Troise blom li neimo blom lu zayma nim* **(SOV)**
Round blom NOM square blom ACC horizontally capture
'The round blom piece captures the square blom piece horizontally.'

(3) *Neimo blom lu zayma nim* **(OV)**
⦸ square blom ACC horizontally capture
'It/another token captures the square blom piece horizontally.'

3.3 Procedure

3.3.1 Vocabulary training

The researcher introduced the vocabulary items aurally with matching still pictures/animations to illustrate their meaning. Vocabulary learning was completely based on sound/picture associations and no translations or visual written stimuli were used here or in any subsequent phase of the experiment. Participants were tested on all vocabulary items at the end of the presentation, and instruction and testing were repeated until participants reached a criterion of 100% in the vocabulary test (Morgan-Short, 2007). The test was receptive; the participants were shown all still pictures and all animations simultaneously and were prompted to point at which picture/animation depicted the word they heard. To ensure vocabulary knowledge had been retained at criterion level, vocabulary testing, and when required vocabulary revision, was repeated at the beginning of each subsequent session.

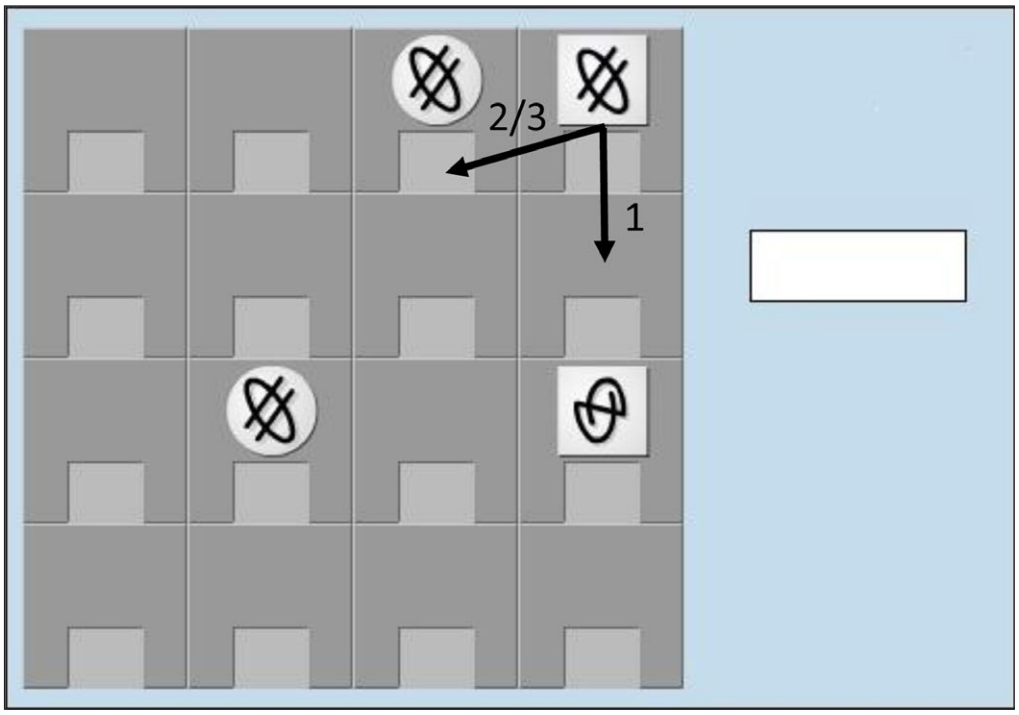

Figure 1: Brocanto game screen exemplifying the moves corresponding to sentences (1), (2), and (3) in the main text.

3.3.2 Exposure blocks

After vocabulary training the participants watched a series of game moves on the screen and simultaneously listened to the BrocantoJ sentence stimuli that described them (144 sentences in total, 24 items per block). The exposure was distributed over six blocks and delivered over three consecutive days (block 1 in session 1, block 2 and 3 in session 2, and block 4, 5 and 6 in session 3). Each exposure block lasted about four minutes and was delivered through an mp4 video, and voiceover sentences were created assembling individual word recordings using AudioJoiner. Recordings were standardized at a length of 700 milliseconds, with 50 milliseconds of silence between each word. All words were recorded and digitized with Audacity by a native British English female research assistant using monotone intonation. Overall token frequency was counterbalanced across vocabulary items belonging to the same category for verbs (except for the intransitive verb *klin*). adjectives and adverbs. The set included three types of sentences: SV, SOV and OV sentences, all attested in Japanese. The first three exposure blocks only included SV and SOV sentences, whilst OV sentences were gradually introduced in the last three blocks. Each sentence type in the set included trials of varying syntactic complexity, depending on whether the aural stimuli specified the direction of movement (adverbs) and one or both of the tokens' shapes (adjectives).

3.3.3 Gaming blocks

Immediately after each exposure block[4] participants played one block of the game Brocanto. The stimuli for the game blocks were novel but of the same type of those the participants listened to in the exposure. The aim of the computer game consisted in performing the correct move after hearing a sentence stimulus describing it in BrocantoJ, and in scoring points for successfully performed moves. The game set contained a total of 120 sentence stimuli, 20 sentences for each of the six game blocks. The game set was counter-balanced for transitive verb type, with two examples of *klin* moves per block. Similarly to the exposure set, OV sentences were gradually introduced in the game from block 3.

The participants were told that they would hear the stimuli only once and were aware that after listening to each sentence they had up to one minute to make their move. The computer program would move on automatically to the next sentence and game configuration after the move was completed or after one minute, if no move was attempted. Unlike in previous Brocanto2 studies, the running score was kept masked during the game to minimize distraction or focus on low performance, especially in the initial game blocks. The program provided immediate feedback after each move in the form of the words 'correct' or 'incorrect', although no further hints as to the reason of the mistakes were given. Only at the end, a percentage correct score was provided to the player. The audio stimuli for the practice blocks were created with the same standardized tracks used in the exposure. Also, additional pauses of 100 milliseconds were introduced between words, so that the speech rate was lower in the game than in the exposure.

Crucially, the case markers *li* and *lu* were included in the exposure and game stimuli, but they were not presented during the vocabulary training and participants were not given hints regarding their presence in the input, their meaning or function. The computer program tracked each participant's gaming performance detailing how each move was performed and its accuracy relative to

the audio stimuli. Participants were not aware that their performance was being recorded during the game or that they would be tested on their language knowledge.

3.3.4 Forced-choice task and debriefing questionnaire

At the end of gaming in session 3, the participants also performed a forced-choice task. In the task they were shown a video with 12 novel moves involving two tokens. After each move, they heard the words *li* or *lu* in isolation and were asked to immediately point at which of the tokens they felt the word associated with. At the end of the experiment verbal reports were recorded to gain information about the amount and type of explicit knowledge of the language the participants had developed during the experiment. The researcher elicited the information in dialogic interaction with the participant using a short questionnaire (Appendix A).

3.4 Outcome measures of language comprehension

For the purposes of the present study, comprehension was operationalized as general sentence comprehension and comprehension of the linking rules (the relationship between arguments or case markers to the corresponding thematic functions). General sentence comprehension was measured by the number of accurately performed game trials overall, while accuracy in the liking rules was measured by the number of accurately performed trials in the relevant trial subset and by the accurate matching between case marker and token in the forced-choice task.

3.4.1 Linking trial subset

Two of the three moves expressed through the transitive verbs ('capture' corresponding to *nim*, and 'swap with' corresponding to *praz*, **Figure 2a** and **2b**) were symmetrical, whilst the third ('release', corresponding to *yab*, **Figure 2c**) was asymmetrical. In symmetrical moves (unlike in the case of *yab*) players had to rely solely on the morphosyntactic information provided in the auditory stimuli (position of the NP in the sentence and case marking on the noun) to perform the correct move out of two alternatives. In other words, they had no contextual hint as to which token would capture the other (*nim*) or which token would have to move first to initiate the swap (*praz*). Hence *nim* and *praz* sentences, corresponding to 68 out of a total of 120 game stimuli, were identified as a subset suitable for the analysis of the development of the understanding of subject/object linking rules across blocks.

3.5 Statistical analysis

As the participants' sample was not sufficiently ample to allow the calculation of reliable inferences, the statistical analysis presented here has mainly descriptive value. Three main analyses were deployed. In order to ascertain that learning on each of the tasks had occurred, participants' attainment was compared to the level of chance performance, i.e., the level of performance expected if they were guessing. To evaluate between-group performance, Chi-Squared tests were performed to compare the proportions of accurate to inaccurate responses in the two groups. For the analysis of within-group performance at different points in time, the McNemar test, a variation of the Chi-squared test suitable for repeated-measure designs, was used. All analyses were performed using the SPSS statistical package (version 20).

4. Results

4.1 RQ1

The frequency data relative to the accurate moves per block were pooled across participants and analyzed per sentence type for the child and the adult group separately (**Table 1**). In order to ascertain when accurate performance represented evidence of learning, a level of chance performance of 14% correct (corresponding to 2.8 items correct per block) was adopted following Morgan-Short (2007, p. 143). Based on that, the threshold of significance above chance was found to lie between 26% and 27% correct responses (rounded up to 27%, 5.4 items correct per block), χ^2 (1) = 5.77, p = 0.024, Φc = 0.155, α = .05 (for this and all analyses henceforth α = 0.05 and p values are exact and two-sided).

Overall accuracy in the game was found to be significantly above chance from block 1 and throughout the game for both age groups (**Figure 3**). An analysis of accuracy scores conducted per sentence type shows that both child and adult responses were significantly above chance for SV, SOV and OV sentences (**Figure 4**). Counts relative to accurate and inaccurate responses for children and adults were analyzed to ascertain whether the difference between the proportions of accurate to inaccurate

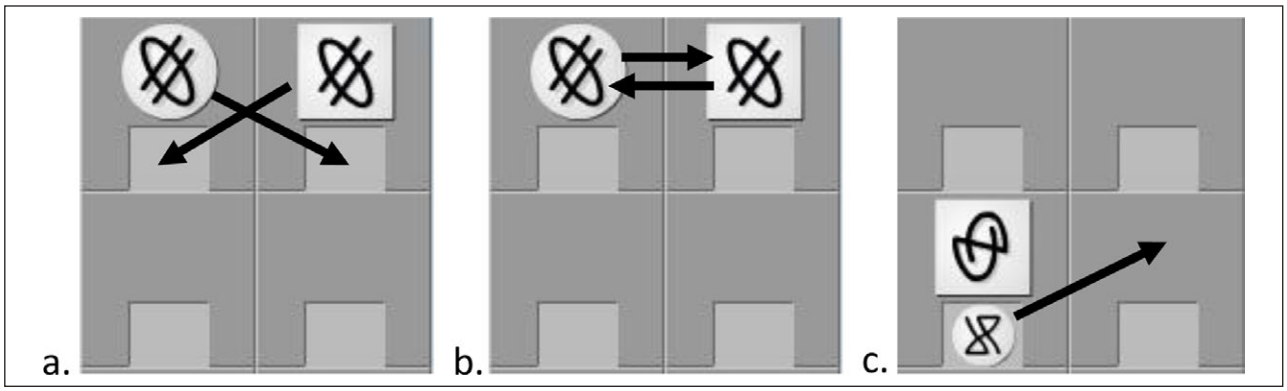

Figure 2: Symmetric moves corresponding to the verbs *nim* **(a)** and *praz* **(b)**, and the asymmetric move corresponding to *yab* **(c)**.

Table 1: Overall count of accurate sentences per block and sentence type. The % in brackets is relative to the total number of sentence stimuli in the block for a given sentence type.

	B1	B2	B3	B4	B5	B6	TOT
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*N* (%)
Children							
SV	8 (66.7)	5 (41.7)	5 (41.7)	9 (90)	8 (80)	6 (60)	41 (62)
SOV	32 (29.6)	39 (36.1)	36 (33.3)	35 (58.3)	45 (81.8)	36 (72)	223 (45.6)
OV	–	–	–	18 (60)	19 (54.3)	23 (57.5)	60 (57.1)
TOT	40 (33.3)	44 (36.6)	41 (34.1)	62 (62)	72 (72)	65 (65)	324 (49)
Adults							
SV	11 (68.8)	9 (56.3)	10 (62.5)	13 (81.3)	16 (100)	13 (81.3)	72 (75)
SOV	55 (38.2)	68 (47.2)	86 (59.7)	63 (65.6)	65 (73.9)	56 (70)	393 (56.4)
OV	–	–	–	29 (60.4)	35 (62.2)	43 (67.2)	107 (63.6)
TOT	66 (41.2)	77 (48.1)	96 (60)	105 (65.6)	116 (72.5)	112 (70)	572 (59.5)

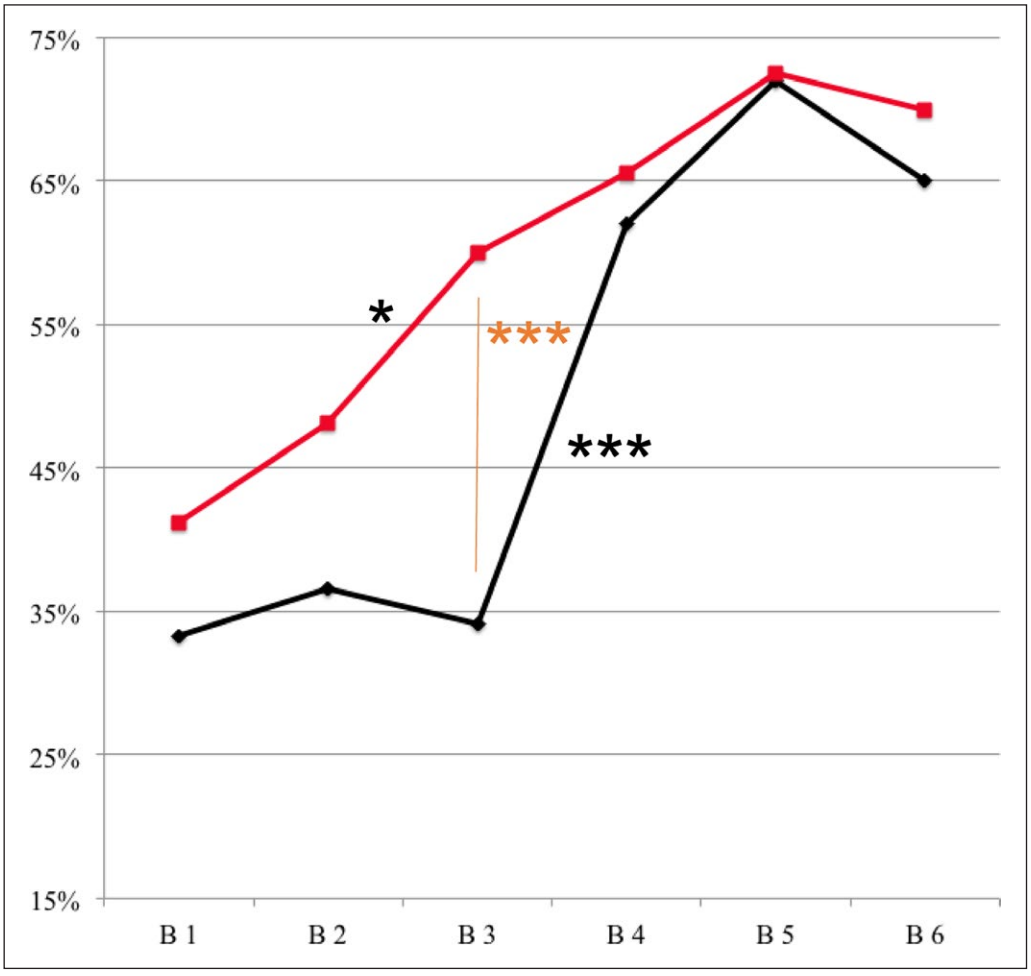

Figure 3: Overall accuracy across blocks for adults (red) and children (black). $^{*}p < .05$ $^{***}p < .001$.

responses in the two groups was significant. Overall, the proportion of correct adult responses was significantly higher but with a small effect size, χ^2 (1) = 17.41, p = 0.000, Φc = 0.104), although a score analysis by block revealed that the difference was significant only at the end of session 2 (block 3), with a small to medium effect size, χ^2 (1) = 18.31, p = 0.000, Φc = 0.256. Response comparisons per sentence type show that in this sample adults were overall significantly better in performing moves associated to SOV sentence stimuli compared to children, although the effect size was again small overall (χ^2 (1) = 13.57, p = 0.000, Φc = 0.107), whilst between-group differences

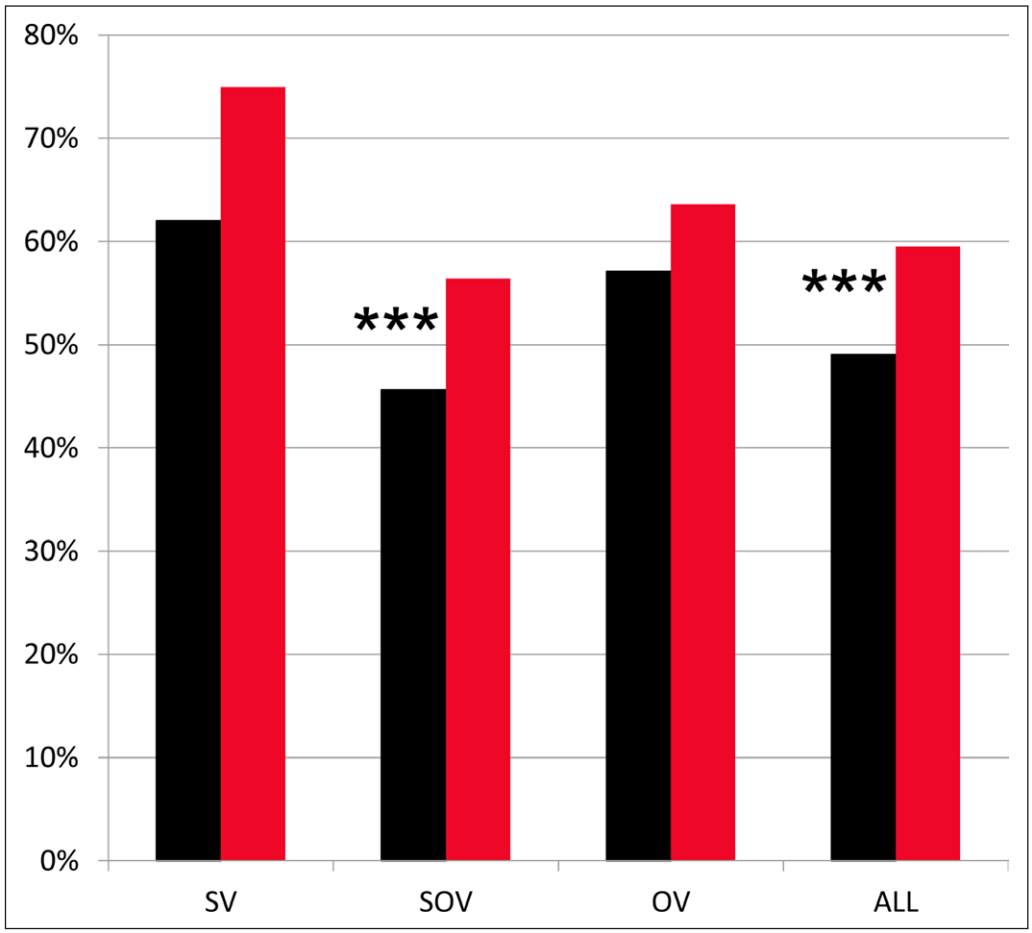

Figure 4: Overall accuracy across sentence types for adults (red) and children (black).

for SV and OV stimuli were not found to be statistically significant. Further analysis that narrowed down the comparison to specific blocks, sentence and verb types found significant effects with larger effect sizes. The between-group difference in block 3 was significant only for SOV sentences, χ^2 (1) = 20.29, p = 0.000, Φc = 0.286, and, among these, only for *nim* SOV sentences, with a medium to large effect size, χ^2 (1) = 17.03, p = 0.000, Φc = 0.450.

An analysis of the within-group gains between blocks was also conducted, this time using the McNemar test, a variation of the Chi-squared test that allows the comparison of proportions relative to related samples. The effect sizes of the within-group analysis were small overall and the analysis found a significant increase in the proportion of accurate child responses between block 3 and 4 (corresponding to the end of session 2 and the beginning of session 3), Z = –4.11, p = 0.000, OR = 1.082. For adult responses, an intrasessional significant gain in accuracy was found between block 2 and 3, Z = –2.06 p = 0.038, OR = 1.008.

Looking at the performance on difference sentence types within-groups (**Figure 4**), children in this sample were significantly more accurate on SV and OV sentences compared to SOV sentences (Z = –2.46, p = 0.014, OR = 1.009 and Z = –2.33, p = 0.019, OR = 1.007, respectively), with no significant differences between SV and OV. No within-group significant differences in the proportion of correct responses per sentence type were found for the adult group.

4.2 RQ2 and RQ3

In order to assess the learning of correct linking rules, a subset of the original data was selected. This included only moves for which accuracy directly depended on the learning of the relationship between the noun-phrase position and its thematic function in BrocantoJ (referred to as symmetrical contexts in the Methods section). Note that linking trials with OV sentences specifically probed the ability to understand linking rules in a context where the only disambiguating element was the case marker, and hence provided direct evidence for the learning of its form-meaning mapping function. Overall, accuracy for linking was again found to be significantly above chance from block 1 and across blocks for both age groups (**Table 2** and **Figure 5**).

The analysis found that overall adults were significantly more accurate than children on stimuli in symmetrical contexts although the effect size of this difference was quite small, χ^2 (1) = 9.53, p = 0.002, Φc = 0.099 (**Figure 6**). However, a significant difference with a larger effect size was found for SOV sentences, χ^2 (1) = 16.22, p = 0.000, Φc = 0.143, whilst there was no significant difference for OV sentences. A comparison of linking accuracy across blocks revealed two statistically significant differences in block 1 and in block 3, with adults performing better compared to children (block 1, χ^2 (1) = 6.68, p = 0.011, Φc = 0.200; block 3, χ^2 (1) = 7.93, p = 0.008, Φc = 0.217). As for within-group differences, no statistically significant

Table 2: Count of accurate sentences per block in symmetrical contexts.

	B1	B2	B3	B4	B5	B6	TOT
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*N* (%)
Children	21 (29.2)	33 (45.8)	30 (41.7)	36 (62.1)	44 (73.3)	35 (58.3)	199 (50.5)
Adults	47 (49)	53 (55.2)	61 (63.5)	62 (64.6)	62 (64.6)	63 (65.6)	348 (60.5)

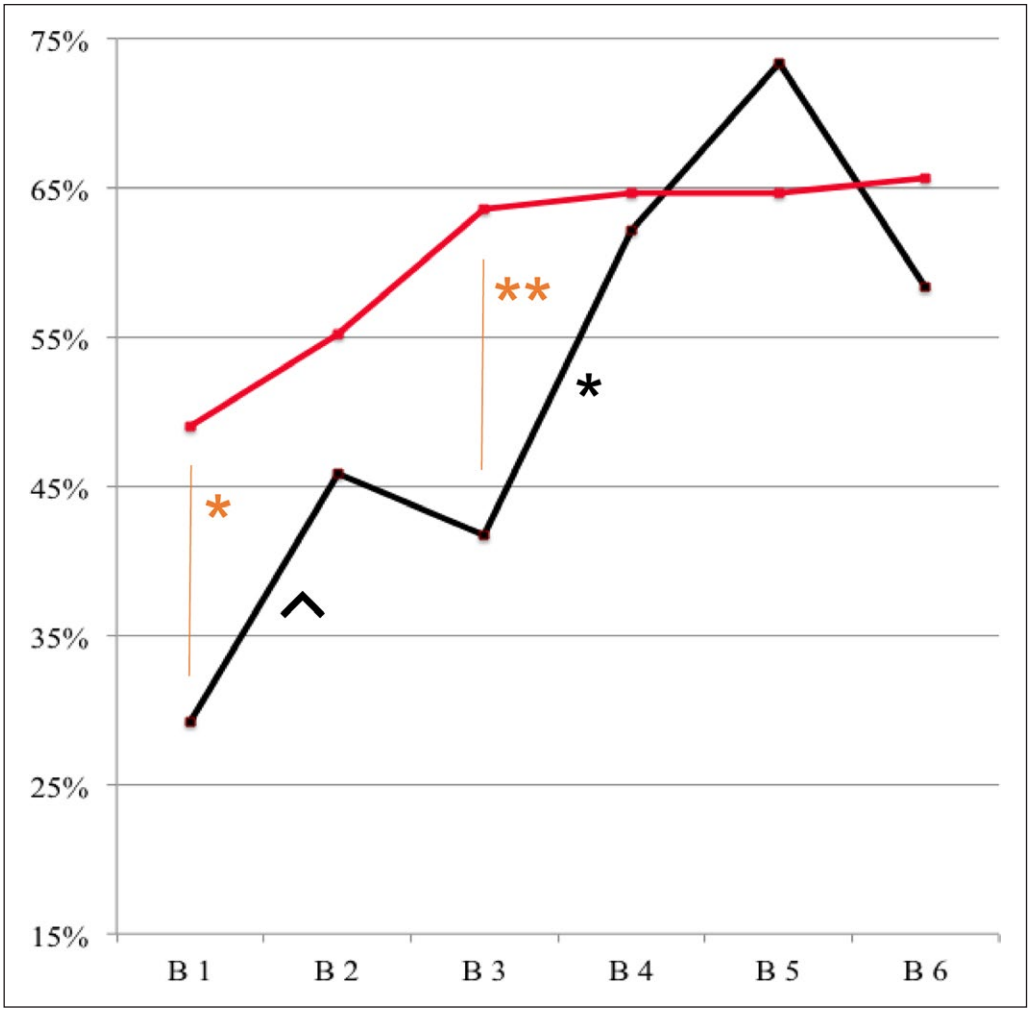

Figure 5: Accuracy based on evidence of correct linking across blocks (symmetrical moves) for adults (red) and children (black). ^.06 < p < .05 *p < .05 **p < .01.

difference emerged relative to how well linking was learnt in SOV versus OV sentences.

Further within-group analysis of the gains in linking accuracy across blocks found that the number of child-accurate responses improved significantly between block 3 and block 4 but with a small effect (Z = –2.193, p = 0.028, OR = 1.041), and very close to significantly between block 1 and 2 (Z = –1.91, p = 0.055, OR = 0.964). No comparable pattern was found for the adult group, which improved performance on linking in a steady way but by smaller increments.

Participants' responses to the forced-choice task were also recorded and pooled according to the age group (**Table 3**). As the response to each task item was binary, the level of chance performance was set at 50%. Based on that, the threshold of significance above chance was calculated to be between 67% and 68%, and rounded up to 68% (χ^2 (1) = 4.85, p = 0.042, Φc = 0.184).

The number of child-accurate responses was below the one expected for chance performance overall (45.8%), as well as when computed for the individual case markers *li* (47.2%) and *lu* (44.4%). The number of correct adult responses, on the other hand, was significantly above chance overall (79.1%), as well as when computed for the individual case markers *li* (79.1%) and *lu* (79.1%). In both cases the within-group differences in proportion between correct *li* and *lu* responses resulted nonsignificant.

In the debriefing interview, when asked whether they had noticed anything special about any of the words, both children and adults reported noticing that *li* and *lu* were not mentioned in the vocabulary training, but were included in the stimuli. Only two adult participants

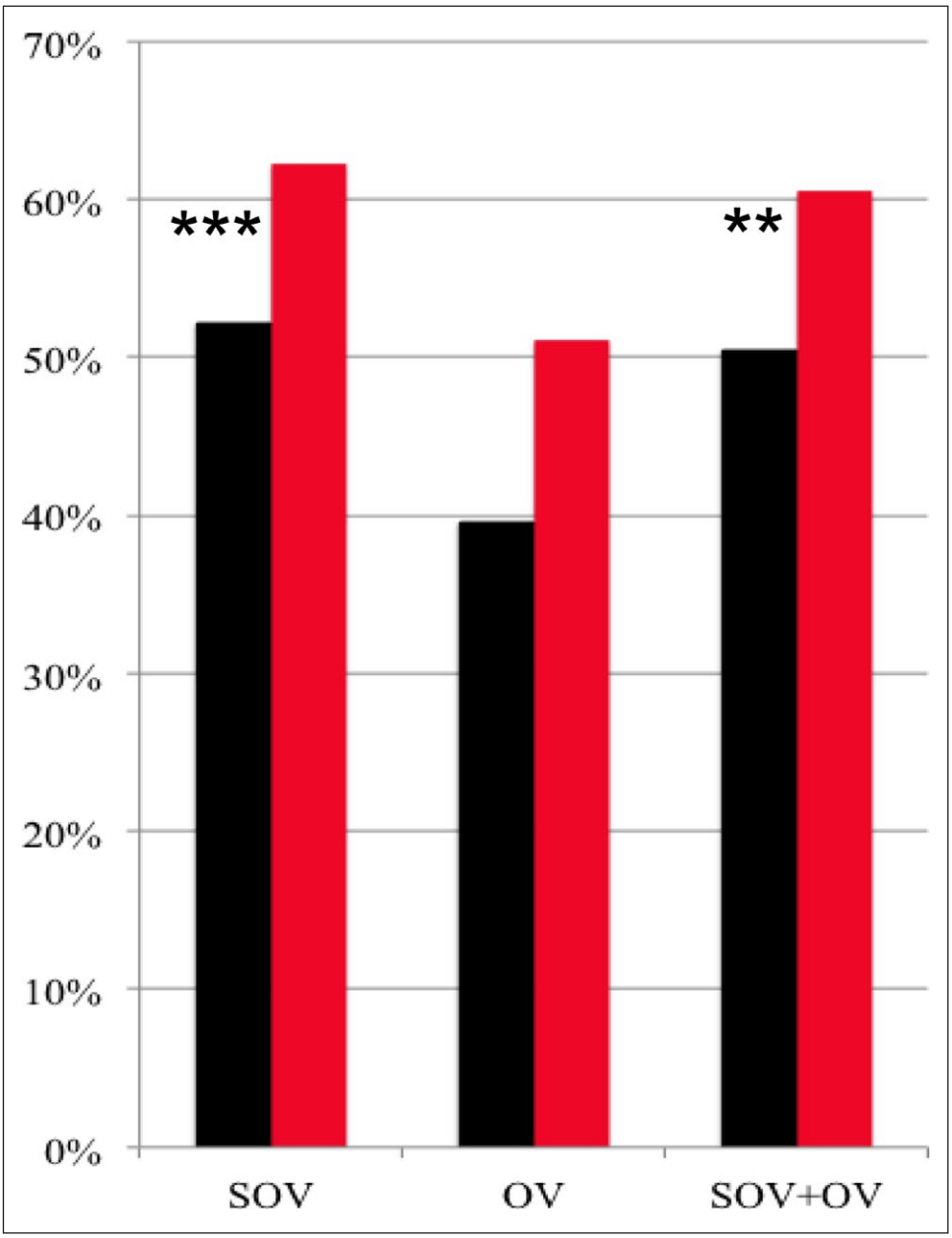

Figure 6: Linking accuracy across sentence types for adults (red) and children (black).

Table 3: Accuracy in the forced-choice task. The % in brackets refers to the proportion of li & lu in accurate and inaccurate responses.

	Children		Adults	
	n **acc. (%)**	***n*** **inacc. (%)**	***n*** **acc. (%)**	***n*** **inacc. (%)**
li	17 (51.5)	19 (48.7)	38 (50)	10 (50)
lu	16 (48.5)	20 (51.3)	38 (50)	10 (50)
TOT	33 (100)	39 (100)	76 (100)	20 (100)

mentioned and described parts of the word order of BrocantoJ correctly. Some participants in both groups said they had tried to work out the meaning of *li* and *lu* during the game. They reported they thought the words could have the function to indicate place/direction, were conjunctions (meant 'and'), had an ordinal meaning (first, second), indicated which element moved, or had a function similar to punctuation. Another adult participant mentioned that during the game she thought the item before *li* 'would probably do something', but wasn't sure if that was a rule. None of the participants was able to describe the linking pattern or the function of both case markers correctly.

5. Discussion

Compared to previous laboratory research, which with few exceptions has tended to adopt a cross-sectional perspective, the present study focuses on the development of child and adult comprehension of word order and linking in a novel L2 over time. Additionally, the investigation was extended to sentences with more complex phrase structure compared to previous child studies. For children and adults, the study found evidence of above-chance learning of the artificial language, both overall as well as with

respect to linking. As the comprehension development data show, improvement in performance was consistent in both groups, and when between-block decreases in accuracy were recorded, they were not statistically significant.

The first research question asked whether children and adults differed in the rate of comprehension of the new language across game sessions. Overall the data suggest that adult performance in receptive skills was superior in the first part of the training (with a statistically significant difference in block 3), but that the age gap had closed by session 3. As such, these results confirm for laboratory contexts, and for the early stages of L2 learning, that the extent to which children and adults differ in their rate of receptive language learning may be less large compared to other language skills (García Mayo & García Lecumberri, 2003).

As for the second research question, the study found that both children and adults learned the argument linking rules in the novel construction statistically significantly above chance, thus confirming the findings of previous research that reported significant learning effects for novel word orders and linking in adults and children. The development of accuracy in linking trials followed a pattern similar to the one found for overall accuracy, with statistically significant between-group differences up to block 3, and comparable attainment in session 3. In particular, statistically significant differences for linking were found in block 1 and in block 3.

Analyzing the type of sentences for which differences were significant can help shed some light on the reason why children appeared to lag behind in the very early phases of training. As already seen in the comparison of overall attainment, SOV, and specifically *nim* SOV sentences, was the only sentence type for which between-group differences were found to be significant in block 3. Between-group differences in the same block for SV or SVO *yab* sentences were not significant. Furthermore, the between-group significant differences in linking found in block 1 and block 3 exclusively reflect weaker child attainment in SOV sentences, as OV sentences were introduced only in block 4. Taken together, these data are compatible with the interpretation that, compared to adults, a delayed understanding of the linking rules for arguments in SOV sentences was a key factor in slowing down child progress in the first part of the training.

Considering the development of L2 comprehension over time, the study found instances of statistically significant improvement between two subsequent blocks for both age groups. However, there were differences with respect to how often and at which point in training these increases in accuracy occurred. In the overall analysis for the adult group there was evidence of a significant improvement during session 2, whilst between-block increments in the accuracy of the linking trials were never significant. In the child group there was a significant improvement between block 3 and block 4 in the overall accuracy. For linking, a very close to significant improvement emerged between block 1 and block 2, together with a significant improvement between block 3 and block 4. In sum, whilst the significant improvement in the adult group was intrasessional, the increases occurred between sessions for children. Also, the trends for linking accuracy in children and adults indicate that child learning of the linking rules occurred in spurts, with intrasessional setbacks during the sessions, whilst adult understanding of linking improved incrementally (cf., **Figure 5**).

Coming to the third research question, this study provided initial evidence that not only adults but also children can learn the relationship between case markers and the thematic content of the associated NP after a relatively short training in implicit instruction conditions. Accurate linking in OV sentences in this case mainly provided the evidence. In the processing of SOV sentences the correct linking between case marker and thematic content could be encoded in the morpheme or could be a by-product of a linking rule depending mainly on the position of the noun phrase the marker is related to. This is not the case in OV sentences where only one argument is present and word order does not provide cues for linking. The fact that linking in OV sentences was accurate significantly above chance in both groups indicates, for the first time in an experiment with child participants, that a relationship between the case marker *lu* and the object's thematic content was successfully established during the course of the experiment.

Finally, the analysis of the accuracy data from the forced-choice task shows that only adults were statistically significantly better than chance in associating individual case markers to the corresponding token (threshold set at 50% correct), and that children were below the level of chance performance on this task. It is important to note that when the participants were exposed to the game moves in this pointing task they heard the markers in isolation and not in a context where they had to process a sentence for meaning, as was previously the case. In particular it is interesting that whilst there is evidence that children learnt the thematic content of *lu* in the context of the game, that knowledge did not transfer to the pointing task. A possibility to account for the difference in adult and child performance on this task is to imagine that adults made more explicit hypotheses about the relationship of the individual elements *li* and *lu* with the associated nouns during training. However, this remains a speculation at present and further research with a design including fine-grained measures of implicit and explicit language knowledge is needed to start addressing these questions.

6. Limitations and Further Research

The main aim of this pilot study was to explore the viability of a comparison between adults and eight- to nine-year-olds in the learning of a fully productive miniature language in implicit instruction conditions, and in a context where learning was measured by the ability to successfully process for meaning auditory stimuli in the form of whole sentences. Although its conclusions can only be tentative, it provides a useful indication to develop further studies where similar research questions can be investigated using larger samples and inferential statistical techniques. Further research could not only

replicate this design on a larger scale, but also extend it, for example by exploring developmental differences in language production.

Secondly, although this pilot study provided some initial evidence that the relationship between the accusative case morpheme and the thematic content of the associated NP can be learned by children and adults, it did not show direct evidence of independent linking for the nominative marker. Further research could address this question offering a consistent differentiation between syntactic linking and morphological linking for transitive constructions.

Future studies could also explore age-related differences focusing on how other aspects of sentence structure (e.g., adjectives, adverbs) affect the online comprehension of complex sentence stimuli.

A further point that future investigations could also address bears on the need for a more in-depth analysis of the type of knowledge learners develop in implicit instruction conditions of the kind described here. In a comparative study with a design similar to the present one, this would necessarily require addressing the issue of the representation of child L2 knowledge in the initial stages of the exposure to a new language, an area of research that to date remains largely unexplored. Finally, as computerized learning environments offer the opportunity to measure response latencies and other online indicators of performance, future studies adopting similar paradigms could explore developmental differences in language processing beyond accuracy.

Additional File

The Additional file for this article can be found as follows:

- **Appendix A.** Debriefing interview. DOI: https://doi.org/10.22599/jesla.25.s1

Notes

[1] Similarly to natural languages, and unlike finite state grammars used in early artificial grammar studies (cf., Reber, Walkenfeld & Hernstadt, 1991), ALs include a lexicon, argument structure, morphology and semantics at sentence and word level.

[2] Here I will refer to explicit training conditions as conditions in which the learner/participant is provided some form of metalinguistic cue or is encouraged to detect patterns during language exposure (independently of the type of knowledge developed as a result of the process).

[3] Here I will adopt a broad definition of implicit conditions as training conditions in which the learner/participant is not provided metalinguistic cues or encouraged to detect patterns during language exposure. Note that implicit training conditions do not imply that (exclusively) implicit knowledge will be developed as a result of the learning process. In the literature review I will refer to incidental learning conditions when this term was used in the original studies.

[4] In order to alleviate fatigue participants were told and reminded they could take three- to four-minutes breaks after exposure or game blocks if they needed to.

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References

Bley-Vroman, R. (1990). The logical problem of foreign language learning. *Linguistic Analysis, 20*, 3–49.

Boyd, J. K., & **Goldberg, A. E.** (2012). Young children fail to fully generalize a novel argument structure construction when exposed to the same input as older learners. *Journal of Child Language*, *39*(3), 457–81. DOI: https://doi.org/10.1017/S030500091200044X

Boyd, J. K., Gottschalk, E. A., & **Goldberg, A. E.** (2009). Linking Rule Acquisition in Novel Phrasal Constructions. *Language Learning*, *59*, 64–89. DOI: https://doi.org/10.1111/j.1467-9922.2009.00536.x

Braine, M. D., Brody, R. E., Brooks, P. J., Sudhalter, V., Ross, J. A., Catalano, L., & **Fisch, S. M.** (1990). Exploring language acquisition in children with a miniature artificial language: Effects of item and pattern frequency, arbitrary subclasses, and correction. *Journal of Memory and Language*, *29*(5), 591–610. DOI: https://doi.org/10.1016/0749-596X(90)90054-4

Brooks, P. J., Braine, M. D., Catalano, L., Brody, R. E., & **Sudhalter, V.** (1993). Acquisition of Gender-like Noun Subclasses in an Artificial Language: The Contribution of Phonological Markers to Learning. *Journal of Memory and Language*, *32*(1), 76–95. DOI: https://doi.org/10.1006/jmla.1993.1005

Casenhiser, D., & **Goldberg, A. E.** (2005). Fast mapping between a phrasal form and meaning. *Developmental Science*, *8*(6), 500–508. DOI: https://doi.org/10.1111/j.1467-7687.2005.00441.x

de Graaf, R. (1997). The eXperanto experiment. *Studies in Second Language Acquisition, 19*, 249–276. DOI: https://doi.org/10.1017/s0272263197002064

DeKeyser, R. M. (1995). Learning second language grammar rules: An experiment with a miniature linguistic system. *Studies in Second Language Acquisition*, *17*(3), 379–410. DOI: https://doi.org/10.1017/S027226310001425X

DeKeyser, R., & **Larson-Hall, J.** (2005). What does the critical period really mean? In: Kroll, J. F., & De Groot, A. M. D. (eds.), *Handbook of Bilingualism: Psycholinguistic Approaches*, 88–108. Oxford: Oxford University Press.

Ferman, S., & **Karni, A.** (2010). No Childhood Advantage in the Acquisition of Skill in Using an Artificial Language Rule. *PLoS ONE*, *5*(10): e13648. DOI: https://doi.org/10.1371/journal.pone.0013648

Friederici, A. D., Steinhauer, K., & **Pfeifer, E.** (2002). Brain signatures of artificial language processing: Evidence challenging the critical period hypothesis. *Proceedings of the National Academy of Sciences, 99*, 529–534. DOI: https://doi.org/10.1073/pnas.012611199

García Mayo, M., & **García Lecumberri, M. L.** (2003). *Age and the Acquisition of English as a Foreign Language*. Clevendon: Multilingual Matters.

Grey, S., Williams, J., & **Rebuschat, P.** (2014). Incidental Exposure and L3 Learning of Morphosyntax. *Studies in*

Second Language Acquisition, 1–34. DOI: https://doi.org/10.1017/S0272263113000727

Ellis, R. (2009). Implicit and Explicit Learning, Knowledge and Instruction. In: Ellis, R., et al. (eds.), *Implicit and Explicit Knowledge in Second Language Learning, Testing and Teaching*, 3–25. Bristol: Multilingual Matters.

Hudson Kam, C. L., & **Newport, E. L.** (2005). Regularizing Unpredictable Variation: The Roles of Adult and Child Learners in Language Formation and Change. *Language Learning and Development*, *1*(2), 151–195. DOI: https://doi.org/10.1080/15475441.2005.9684215

Hudson Kam, C. L., & **Newport, E. L.** (2009). Getting it right by getting it wrong: When learners change languages. *Cognitive Psychology, 59*(1), 30–66. DOI: https://doi.org/10.1016/j.cogpsych.2009.01.001

Lichtman, K. (2012). Child-adult differences in implicit and explicit second language learning. Unpublished Ph.D dissertation, University of Illinois at Urbana-Champaign.

Lichtman, K. (2016). Age and learning environment: Are children implicit second language learners? *Journal of Child Language*, *43*(3), 707–730. DOI: https://doi.org/10.1017/S0305000915000598

MacWhinney, B. (1983). Miniature linguistic systems as tests of the use of universal operating principles in second-language learning by children and adults. *Journal of Psycholinguistic Research, 12*(5), 467–478. DOI: https://doi.org/10.1007/BF01068027

Morgan-Short, K. (2007). A neurolinguistic investigation of late-learned second language knowledge: The effects of explicit and implicit conditions. Ph.D dissertation, Georgetown University.

Morgan-Short, K., Sanz, C., Steinhauer, K., & **Ullman, M. T.** (2010). Second language acquisition of gender agreement in explicit and implicit training conditions: An event- related potential study. *Language Learning, 60*, 154–193. DOI: https://doi.org/10.1111/j.1467-9922.2009.00554.x

Muñoz, C. (2006). The Effects of Age on Foreign Language Learning: The BAF Project. In: Muñoz, C. (ed.), *Age and Rate of Foreign Language Learning*, 1–40. Clevendon: Multilingual Matters.

Reber, A., Walkenfeld, F., & **Hernstadt, R.** (1991). Implicit and explicit learning: Individual differences and IQ. *Journal of Experimental Psychology: Learning, Memory and Cognition, 11*, 888–896. DOI: https://doi.org/10.1037/0278-7393.17.5.888

Rebuschat, P., & **Williams, J. N.** (2012). Implicit and explicit knowledge in second language acquisition. *Applied Psycholinguistics, 33,* 829–856. DOI: https://doi.org/10.1017/S0142716411000580

Rogers, J., Révész, A., & **Rebuschat, P.** (2015). Implicit and explicit knowledge of inflectional morphology. *Applied Psycholinguistics*, 1–32. DOI: https://doi.org/10.1017/S0142716415000247

Spada, N., & **Tomita, Y.** (2010). Interactions Between Type of Instruction and Type of Language Feature: A Meta-Analysis. *Language Learning, 60*(2), 263–308. DOI: https://doi.org/10.1111/j.1467-9922.2010.00562.x

Williams, J. N., & **Kuribara, C.** (2008). Comparing a nativist and emergentist approach to the initial stage of SLA: An investigation of Japanese scrambling. *Lingua, 118*, 522–553. DOI: https://doi.org/10.1016/j.lingua.2007.03.003

Wonnacott, E., Boyd, J. K., Thomson, J., & **Goldberg, A. E.** (2012). Input effects on the acquisition of a novel phrasal construction in 5-year-olds. *Journal of Memory and Language*, *66*(3), 458–478. DOI: https://doi.org/10.1016/j.jml.2011.11.004

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