SESSION 1

Does AGENT-first bias guide sentence comprehension? Evidence from eye-tracking

Jingtao Zhu & Anna Gavarró

Since the overwhelming majority of natural languages manifest the SO order, whereas the OS order is rare (about 3.4%, Dryer, 2013, WALS), this could suggest a tendency for young infants to assume that the first NP in a two-NP sentence is the AGENT of a causative transitive sentence (as postulated by Bever 1970, and, more recently, Lidz et al. 2001). However, this strategy would lead to misinterpretations when the learner encounters a structure like (1a) from Chinese, where the first NP is the THEME. In this study, we resorted to the preferential looking paradigm to test comprehension of word order alternations in Mandarin Chinese on both canonical SVO (2) and non-canonical sentences involving the *ba* construction (1a,b) using pseudo-verbs. In the *ba* construction, the object raises from its canonical, postverbal position to the position immediately following *ba*, leading to a surface S*ba*OV structure (as in 1b).

24 typically-developing Mandarin infants with a mean age of 17;5 months (*SD* = 2.2) participated in our experiment. Children were showed two simultaneous videos while their eye fixation times were measured: in one video, the target causative event was depicted, while the other screen illustrated the same event with theta-role reversal. Each pair of videos included four windows: (i) the presentation of the videos with a baseline sentence of the type *Look! What is happening?* and (ii) three consecutive presentations of the experimental sentence, starting at 5, 10, and 15 seconds (S1, S2, S3 in figure 1).

The results in table 1 show that in the AGENT-first SVO and S*ba*OV conditions, infants preferred looking at the scene with the first NP being the AGENT. However, in the OS*ba*OV condition, they looked longer at the scene with the first NP as THEME during the first ($t(23) = 3.35$, $p = .003$, $d = .65$) and the second presentation ($t(23) = 2.08$, $p = .049$, $d = .57$). The proportion of looking time to the scene with the first NP as AGENT (calculated over the total of looking time, see figure 1) differs significantly between the SO and OS conditions during the first (Wilks' Lambda = .709, $F_{2,22} = 4.52$, $p = .023$, $\eta^2_p = .291$) and the second presentation (Wilks' Lambda = .535, $F_{2,22} = 9.57$, $p = .001$, $\eta^2_p = .465$) and follow-up comparisons indicated that differences between SVO and OS*ba*OV, and S*ba*OV and OS*ba*OV were both significant ($p = .001$ and $p = .031$, respectively), while the difference between the two AGENT-first constructions (i.e. SVO and S*ba*OV) were not statistically significant.

From these we conclude that infants exposed to Mandarin are sensitive to the target word order from age 17;5 at the latest. Note that the *ba* construction is furthermore scarce in the child-directed speech (only about 3.1%, Zhu & Gavarró, 2017). Thus, our results cannot be explained by an AGENT-first parsing strategy, as THEME-first OS*ba*OV was parsed in a target-like manner. This finding holds for canonical as well as non- canonical word orders using pseudo-verbs, a result only available, to our knowledge, for French Clitic Left dislocation (Lassotta et al., 2015). Therefore, the predictions of an ad-hoc strategy such as AGENT-first are not fulfilled.

(1a) 小鸭子 小兔子 把 它 tuān 了。
the duck the rabbit BA it PSEUDO-VERB PERF
(1b) 小兔子 把 小鸭子 tuān 了。
the rabbit BA the duck PSEUDO-VERB PERF
(2) 小兔子 tuān 了 小鸭子。
the rabbit PSEUDO-VERB PERF the duck
'The rabbit V-ed the duck.'

	SVO		S*ba*OV		OS*ba*OV	
	Target	Reverse	Target	Reverse	Target	Reverse
Baseline	1299(589)	1410(820)	1931(852)	1659(746)	1394(665)	1163(715)
Sentence 1	1511(916)	1451(853)	2273(1103)	1829(957)	**1867(986)** **	**1289(785)** **
Sentence 2	**1660(837)** *	**1139(890)** *	**1944(1193)** *	**1396(933)** *	**1888(1102)** *	**1323(868)** *
Sentence 3	**1523(865)** ***	**1026(628)** ***	1595(1079)	1900(1204)	1364(1060)	1290(825)

Table 1. Mean looking times across the four critical areas of interest in three conditions.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$ (in bold)

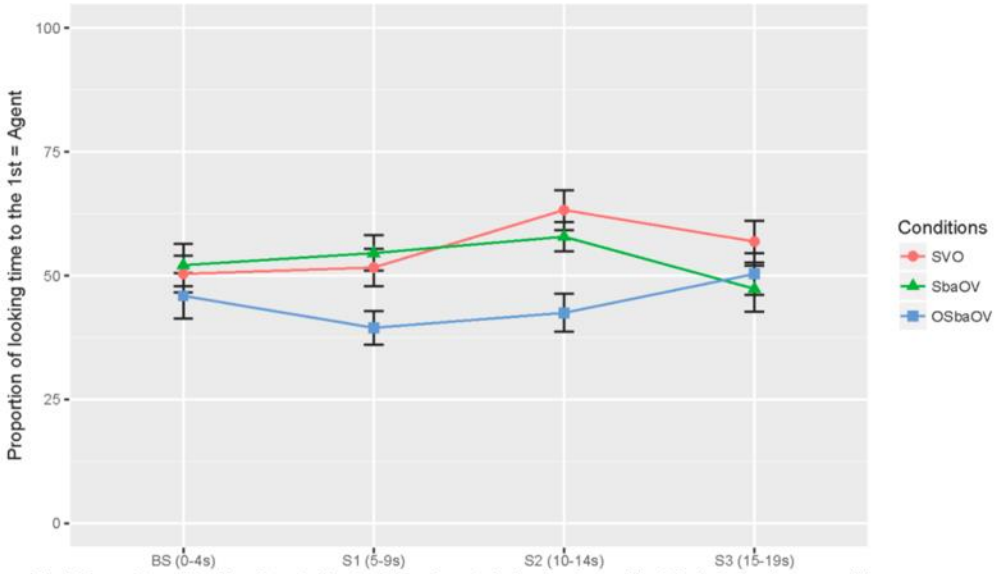

Fig.1 Proportion of looking time to the 1st NP = Agent during the four critical AoIs in the three conditions.

How the global contextual information shapes the Constraining and Cloze Probability Effects on Chinese Classifier-Noun Agreement

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A growing body of evidence has demonstrated that readers could utilize the contextual information for pre-activating the features of upcoming words during sentence comprehension. Our previous study manipulated the constraint (strong versus weak) of the classifiers and the cloze probability of the upcoming nouns (high versus low) and found the interaction between these two parameters on N400. The current study aims to investigate the modulation effect of the sentential constraint on the local constraint of classifier-noun agreement by embedding the classifier-noun pairs in a sentence context. In addition to the constraint of the classifier, we further manipulated the global expectancy between sentential context and the ending noun, as to whether the ending noun was semantically expected (G+) or unexpected (G-) to the preceding sentence. The results suggested that the global context would modulate the local predictability. For G+ preceding sentences, the cloze probability effect, in which the low cloze noun elicited greater N400 than the high cloze one, was only found when the ending nouns were followed by a strongly constraining classifier, but not by a weakly constraining classifier. The preserved cloze probability effect under strongly constraining classifier may reflect the benefit from strong prediction and the increased effort to mitigate the cost for misprediction. For G- preceding sentences, the N400 component was only affected by the local constraint of the classifier. When the G- preceding sentence failed to predict the target words, the strongly constraining classifier could remain its effect on its pairing noun. Moreover, the increased late positivity for low cloze probability was observed. An enlarged late positivity might indicate a more difficult process of integrating the current word with different levels of context to construct a coherent representation. Overall, the present findings showed that the contextual information could override the local predictability. When the local constraint of context can influence the degree of pre-activation, it appears to facilitate the process of the upcoming word, as reflected by the modulation of N400.

Keywords: Multiple constraints, Sentence comprehension, Chinese Classifier-noun agreement, N400

Modulating "Surprise" with Syntax: a case study on Negative sentences

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This work explores how a particular case of negative sentences, the *Surprise Negation Sentences* (SNEGs) (Greco 2018, 2019), is interpreted by measuring eye-movements in a visual world paradigm (Altmann & Kamide 1999; Salverda, Brown, & Tanenhaus 2011). SNEGs belong to the class of expletive negation sentences, i.e. they are affirmative in meaning but involve a clausal negation (Horn 1989; Jespersen 1917). A clear example is offered by Italian: 'E *non* mi è scesa dal treno Maria?!' (let. and *neg* CL.to me is got off-the train Mary; '*Maria got off the train*!'). From a theoretical point of view, the interpretation of SNEGs as affirmative can be derived from their specific syntactic and semantic structure (Greco 2018). Here we offer a novel experimental paradigm to test how SNEGs are interpreted facing two questions: (i) how is negation processed when it does not deny a sentence, as it is supposed to do? (ii) Are EN sentences elaborated either as affirmative clauses, according to their semantic value, or as negative clauses, according to their morphological shape?

Our conditions were generated by listening to three types of target sentences – affirmative (e.g., *The girl showed a snake*), negative (e.g., *The girl did not show a snake*) and Sneg (e.g., '*La ragazza non ha mostrato un serpente?!'* translated as *The girl showed a snake!*) – which followed a short real-life story (e.g., *Laura invited some friends to her home. When they arrived, she showed her domestic animal to them*) while four photos were presented on the screen: two belonged to the semantic category introduced by the story, corresponding either to the highly unexpected one (e.g., a *snake*) mentioned in the target sentence or to a highly expected one (e.g., a *dog*); the other two were distractors (e.g., a *backpack* and an *air-conditioning*) (***fig. 1***). Because only two objects were compatible with the discourse context, this configuration provided a binary visual contest in which the differences between affirmative and negative clauses could emerge (Orenes, Beltrán & Santamaría 2014; Orenes et al. 2016).

Our predictions were that in such a linguistic context (i) individuals should show an increased probability of fixating the mentioned (unexpected) object in both affirmative and Sneg sentences but not in negative ones; (ii) individuals should show an increased probability of fixating the not-mentioned (expected) object after some thousands of milliseconds in negative sentences due to the late integration of negation (Hasson & Glucksberg 2006; Giora 2006; Kaup, Lüdtke & Zwaan 2005, 2006) but not in affirmative and Snegs sentences. Overall, these predictions were confirmed. Growth Curve Analysis showed that the fixation patterns to the relevant objects on the screen was very similar for affirmative and expletive negative sentences, while striking differences were observed between negative and affirmative sentences. More specifically, participants kept looking at the unexpected (mentioned) object (*e.g. the snake*) (***fig. 2***) after hearing the negative particle in negative, but not in Sneg or in affirmative sentences. Coherently, the subjects' attention increased on it on the second half of the time epoch (the inflection point of the fall-rise shape occurs during to the mention of the object) for both affirmative (e.g., *The girl showed a snake*) and Sneg cases (e.g., *The girl* ***non*** *showed a snake!*) because it realizes the actual meaning of the proposition, whereas this does not occur in negative sentences (e.g., *The girl did not show a snake*) because of negation. With regard to the expected (not-mentioned) object (e.g. *the dog*) (***fig. 3***), participants move their gaze *away* from it to elsewhere on the screen, at the beginning of the negative sentences, and then they return on it later in the sentence. This suggests that participants build a representation of the most likely scenario early on (the domestic animal the girl will show is a dog), and negate it soon after the *non*; then, when they build the effective meaning of the sentence listening to it

(*The girl did not show a snake*) they turn back to the *dog*. This moving away from – turning back to the expected object does not happen with Sneg and affirmative sentences, confirming our second prediction. These results showed that negation does play a different role in the mental representation of a sentence, depending on its syntactic derivation.

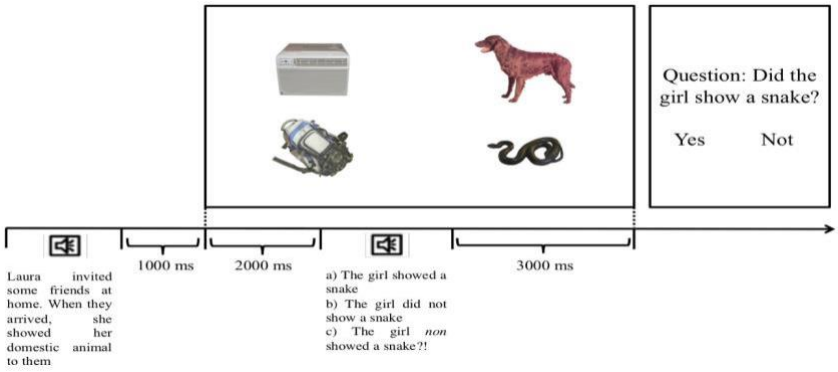

FIG 1: Experiment Time-line (the sentences are translated in English from Italian)

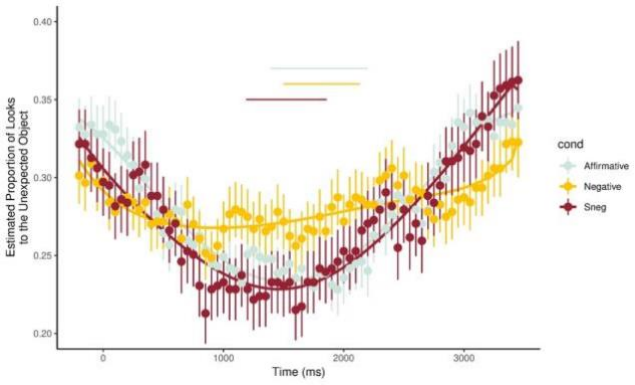

FIG. 2: Fixation proportion to unexpected object during the target sentences; respectively, in grey for affirmative sentences, in yellow for negative sentences and in dark red for Sneg sentences. The offset of the 2nd word of each sentence is represented on the horizontal axis by 0. The three horizontal segments represent the moment in time when, on average, the sentence object was pronounced. Error bars depict Standard Error of the mean.

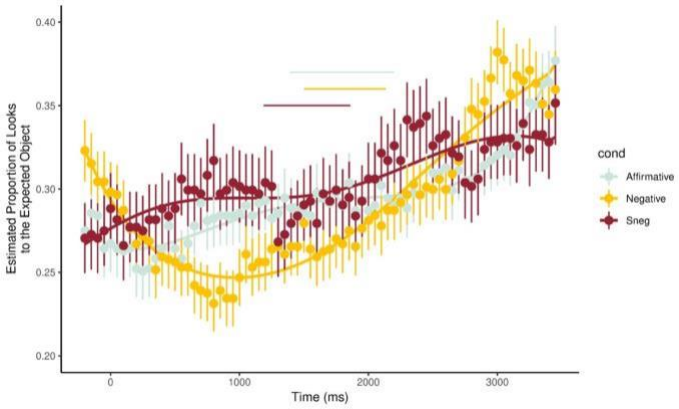

FIG 3: Fixation proportion to expected object during the target sentences; respectively, in grey for the affirmative sentences, in yellow for the negative sentences and in dark red for the Sneg sentences. The offset of the 2nd word of each sentence is represented on the horizontal axis by 0. The three horizontal segments present when, on average, the sentence object was pronounced. Error bars depict Standard Error of the mean.

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SESSION 2

The Universal Language Network

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Language evolved for the purpose of communication, spreading across the globe over the last ~1.8 million years to culminate in the current ~7000 languages encapsulated in 150 families (Ostler, 2005). These languages differ in a wide array of characteristics, from diverse sound inventories, to distinct derivational and functional morphology systems, to different word order preferences. However, this cross-linguistic richness and diversity is severely under-investigated in most psycholinguistic and neurobiological research, with most studies focusing on English and a handful of Western European languages (Bornkessel-Schlesewsky & Schlesewsky, 2016).

To test whether the general functional architecture of language is similar across typologically varied languages, we undertook a large fMRI study spanning 41 languages across 10 language families (Afro-Asiatic, Austronesian, Dravidian, Indo-European, Japonic, Koreanic, Sino-Tibetan, Turkic, and Uralic) as well as one isolate (Basque). Neural responses were recorded from 84 participants (2 per language) as they listened to passages from 'Alice in Wonderland' in their native language, as well as acoustically degraded versions of those passages, and passages in an unfamiliar language. The contrast between speech and acoustically degraded speech has been previously shown to robustly and reliably activate the high-level language processing network (Scott et al., 2016), similar to other contrasts between language and degraded language conditions (e.g., Fedorenko et al., 2010). To assess the selectivity of the language-responsive areas for language (Fedorenko et al., 2011), participants also performed a spatial working memory task and an arithmetic addition task. Finally, participants performed two naturalistic cognition paradigms: a resting state scan, and a ~5-minute long passage in their native language.

The functional architecture of language processing was found to be robust across diverse languages. *First*, the activation landscape for the intact>degraded and the intact>foreign contrasts is remarkably consistent across languages and language families, with the activations covering extensive portions of the lateral surfaces of left frontal and temporal cortices, with stronger activity in the left hemisphere. *Second*, the language-responsive regions are highly selective, showing no response to spatial working memory or arithmetic, although both elicit robust responses in the domain-general multiple demand (MD) network (Duncan, 2010). And *third*, functional correlation analyses revealed that the language network is highly internally integrated, with the regions showing strong correlations during both rest and story comprehension, and r=~0 correlation with the regions of the MD network, replicating Blank et al.'s (2014) results in English.

The similarity of the basic functional architecture of language across 41 diverse languages is striking given the vast cross-linguistic differences in the sound structure, morphology, lexicon,

and syntactic systems. On the other hand, language is an evolutionary late invention, with many perceptual, motor, and cognitive systems already in place at the time when language emerged. Those pre-existing mechanisms plausibly constrained the organization of the language network. In spite of these broad similarities in the language architecture, some of the linguistic computations may be implemented differently across different languages. This work lays the foundation for future investigations of fine-grained linguistic manipulations to uncover potential dissociations in their neural implementation cross-linguistically.

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Relating Surprisal to the N400 and P600: A neurocomputational model

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The language comprehension system maps the unfolding linguistic signal into rich meaning representations. Cognitive computational models of this system seek to account for how such understanding is accomplished, in a manner that is both informed by – and explains – online behavioural and neurophysiological indices of language comprehension. Salient measures include the relationship of a word's contextually-determined likelihood (or, *surprisal*) with that word's reading time (Hale, 2001; Levy, 2008), as well as the lexical, integration, and revision processes indexed by event-related potentials such as the N400 and P600.

We present a neurocomputational model based on the above assumptions and observations. We begin by motivating the *neural semantics* framework (Frank, Koppen, Noordman & Vonk, 2003; Venhuizen, Crocker & Brouwer, 2018), which not only supports the representation of complex logical forms, but also encodes their likelihood in the world, and supports probabilistic, knowledge-driven inference. Critically, these representations further support the computation of a 'meaning-centric' notion of surprisal *S(wt)*, on a word-by-word basis, that reflects both the *linguistic expectancy* of that word (as determined by linguistic frequencies), and the *likelihood of the meaning* (in the world) it induces (Venhuizen et al, 2018). The neurocomputational model of Brouwer, Crocker, Venhuizen & Hoeks (2017) — which identifies a clear linking hypothesis to both the N400 (lexical retrieval) and P600 (semantic integration) ERP components — is then adapted to use this representational approach (Figure 1). Key predictions of the model are that semantic integration difficulty should (a) result in increased surprisal, which should further (b) be manifest as an increased P600 amplitude, while (c) the N400 reflects contextually-driven retrieval processes.

Findings from a recent ERP experiment designed to test these predictions, against those of alternative accounts, are then presented. Both the ease of retrieval (target word is *related* (a&b) or *unrelated* (c) to the discourse event context) and the ease of integration (target word is judged as plausible (a) versus implausible (b&c) given the event context) were manipulated (see conditions below). The findings confirm predictions generated by the model, namely that the P600 component indexes general semantic integration and not, e.g., syntactic revision processes alone, while the N400 appears to be predominantly driven by contextually-driven retrieval (i.e. priming), rather than integration processes (See Figure 2). Taken together, the presented model and ERP findings offer a theoretically, computationally and empirically grounded account of both the processes involved in recovering utterance meaning, and their manifestation in behavioural (surprisal-driven reading times), and electrophysiological (N400 as retrieval, and P600 as integration/surprisal) measures.

Experimental conditions:

1. John entered the restaurant. Before long, he opened the menu and... (*baseline condition*)
2. John left the restaurant. Before long, he opened the menu and... (*event related violation condition*)
3. John entered the apartment. Before long, he opened the menu and... (*event unrelated violation condition*)

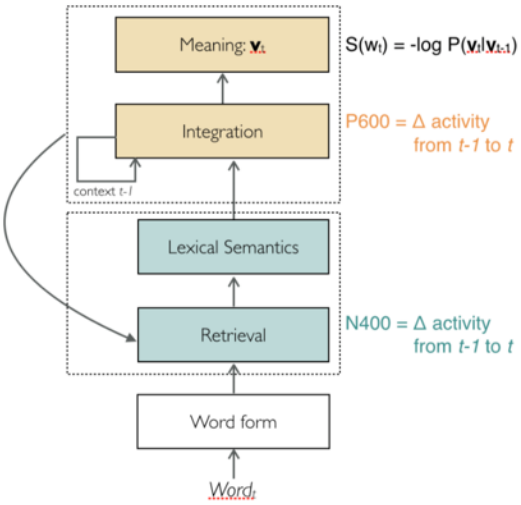

Figure 1. The Neurocomputational Model

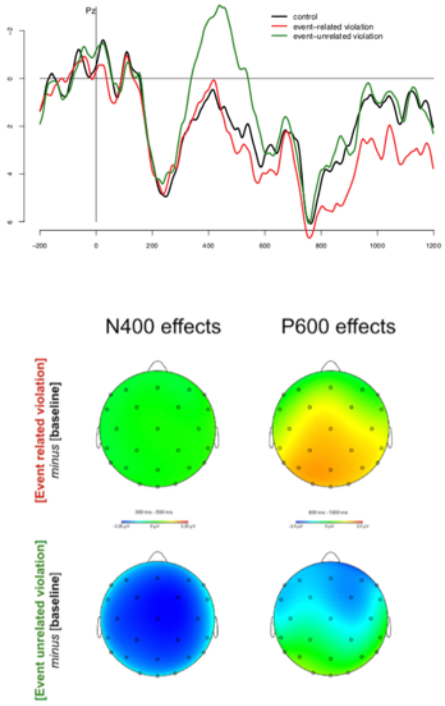

Figure 2. ERPs (Pz) and topographic maps for N400 and P600 time windows

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Disentangling syntactic and semantic components in basic adjective-noun composition: An MEG study

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The possibility to combine smaller units of meaning (e.g. words) to create new and more complex meanings (e.g., phrases and sentences) is a fundamental feature of human language. While natural language utterances are clearly more complex, we can take composition of a minimalistic phrase such as "white horse" as a starting point for investigating brain dynamics supporting linguistic combinatory processing. In processing such a phrase, some sort of syntactic composition has to take place (determining that it is the adjective that is modifying the noun) as well as meaning composition (applying the color *white* feature to the idea of a *horse*).

Processing a noun in a minimalistic compositional context (e.g., "white horse") as opposed to a non-compositional context (e.g., "zgftr horse") has been consistently found to be supported by the left anterior temporal lobe (LATL) with its activity peaking at 200-250 ms after noun onset (e.g., MEG studies of Bemis & Pylkkänen 2011; Westerlund & Pylkkänen 2014). However, at such an early time-window the meaning of the noun is not yet fully retrieved, so only nouns whose meaning does not involve a high level of detail (e.g., "animal", but not "horse") can be composed this early, and only with adjectives whose meaning does not critically depend on the noun's meaning (e.g., "dead horse", but not "large horse" where the meaning of "large" is dependent on the object to which it is applied; Ziegler & Pylkkänen 2016). The first goal of the present study was to replicate these findings of LATL involvement in combinatorial processing and its modulation by adjective and noun properties.

Notice that such an experimental design does not distinguish between syntactic composition and semantic composition, since they are both present in the compositional context and both absent in the non-compositional context. In the present project, we therefore extend this design to include an additional condition with the goal to disentangle specifically syntactic composition in minimalistic phrases. We do so by exploiting an adjective-noun agreement feature in Dutch where adjectives have to agree with the nouns that they modify in terms of the noun's grammatical gender ("een klein paard" [a small horse], but "een kleine vogel" [a small bird]). In our additional condition, participants see nouns preceded by nonwords that are marked appropriately for grammatical gender (i.e., agreeing with the grammatical gender of the following noun) as if they were adjectives. We make sure that there are no meanings associated with nonwords. With this condition, our goal was to investigate involvement of LALT in the case where there is syntactic composition, but not meaning composition.

A second line of research into composition of minimalistic phrases used fMRI and compared determiner-noun (e.g., "this apple") composition with either nonword-noun composition (Zaccarella & Friederici 2015) or single noun processing (Schell et al. 2017). The results in this line of research ascribe a crucial role to the left inferior frontal gyrus (LIFG) in supporting specifically syntactic composition. However, fMRI does not allow one to investigate the time-course of LIFG involvement. In the present project, the MEG data of the nonword condition allows us to explore the time-course of potential LIFG involvement in syntactic only composition as opposed to non-compositional context.

In the present study, participants (N= 40) see an 'adjective' followed by a noun (see *Figure 1*). We present 80 nouns (40 high- and 40 low-specificity) in 4 adjective conditions (see *Table 1*), all in Dutch. We record MEG signals using a whole-head MEG system with 275 axial gradiometers and follow the pre-processing steps used by Ziegler & Pylkkänen (2016). For the replication analyses, we will conduct RM ANOVA tests (Adjective type [2] X Noun type [2]) on average amplitudes of LATL activity during noun processing in the early (200-317 ms) and late (350-471 ms) time-windows from the original study.

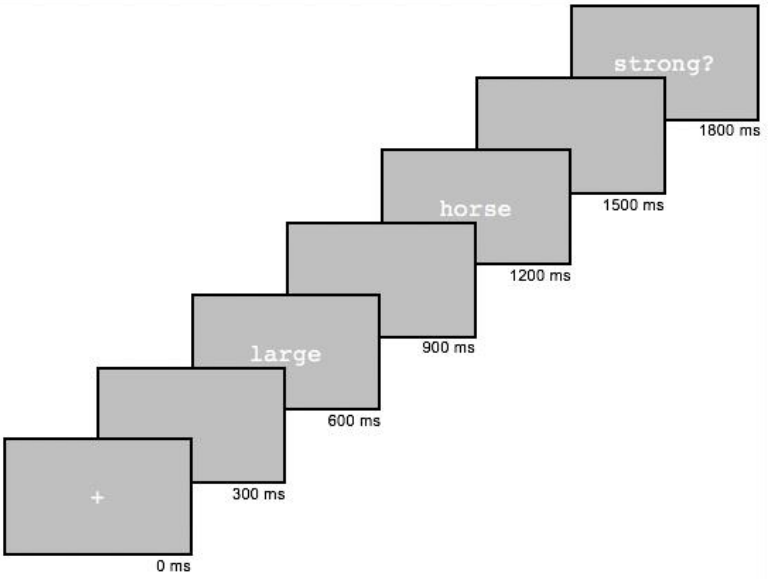
Successful replication will strengthen our confidence in the suggested role of LATL. For the comparisons with our nonword condition, we will conduct exploratory cluster-based permutation tests on the whole time-window of noun presentation in LATL and LIFG. These results will shed light on the role of LATL specifically in syntactic composition, as well as whether and in which time-window the LIFG is involved during purely syntactic composition.

Table 1. Example adjectives and nouns in each of the conditions. The line filled with gray color indicates the condition that we add in this study in comparison to Ziegler & Pylkkänen (2016).

Figure 1. Trial structure. We used a trial structure parallel to Ziegler & Pylkkänen (2016). The comprehension question is included to ensure participants combine the meanings of the adjective and the noun. NB: English is used only for demonstration purposes.

References

Condition	Adjective	Low spec noun	High spec noun	Components
scalar	groot(e) [large]	dier [animal]	paard [horse]	syn+sem
intersective	dood(e) [dead]			syn+sem
nonword	mouw(e)			syn only
letter string	hzgmr			none



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SESSION 3

The Influence of Verb Bias on Online Mandarin Objective Relative Clause (ORC) Processing: an ERP study

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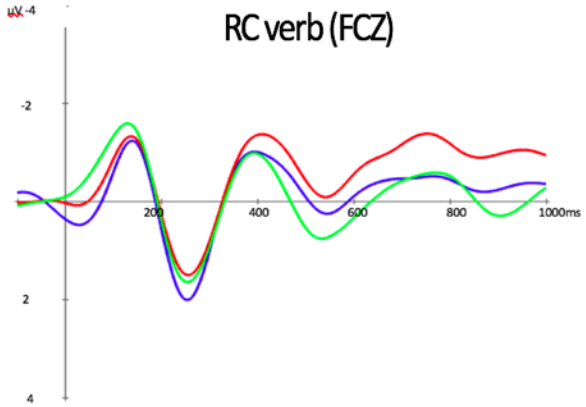
The preference for processing either subjective (SRC) or objective relative clauses (ORC) in Mandarin has been extensively investigated in studies of sentence comprehension. However, inconsistencies are found across theories (Bever,1970; Gibson, 2000; Jäger, et al. 2015; MacWhinney, 1977) and psycholinguistic experiments (Chen,2008, Hsiao & Gibson, 2003; Lin & Bevers 2006; Sung, 2016) which might appear to arise from the fact that most of the studies focus on the RC structure itself, but other factors such as context should be also taken into account. Hence, this study aims to investigate how verb bias which carries both syntactic and semantic information incrementally modulates RC processing in Mandarin. 41 verbs chosen from Sinica Corpus were classified into three types of biases: Direct Object (DO), Sentential Complement (SC), and Equilibrium Balanced (EQ). Each verb is followed by an ORC (1st noun + RC verb + RC marker DE + head noun). Relative to the SC-bias condition, several effects were seen in the DO-bias condition, including a frontal positivity (630- 1000ms) to the RC verb (Figure 1), indicating the difficulty of processing unexpected but plausible syntactic structure, an N400 effect to DE (Figure 1), reflecting the difficulty of integrating DE to the expectation of "the concept of event", and a late frontal negativity (650- 850ms) to head noun (Figure 1), suggesting the need of establishing the referential binding between the DO-bias verb and its correspondent referent (direct object) . While verb exhibits clear tendency (DO and SC-bias verb) towards specific syntactic and semantic information, readers use the verb's embedded information to predict upcoming structure. EQ-bias verbs following ORCs exhibit a similar pattern as the DO-bias verbs did. When processing the verbs without a clear tendency, readers tend to expect the simplest syntactic structure- direct object following the main verb. In sum, this study provides ERP evidence that verb bias incrementally influences Mandarin RC processing.



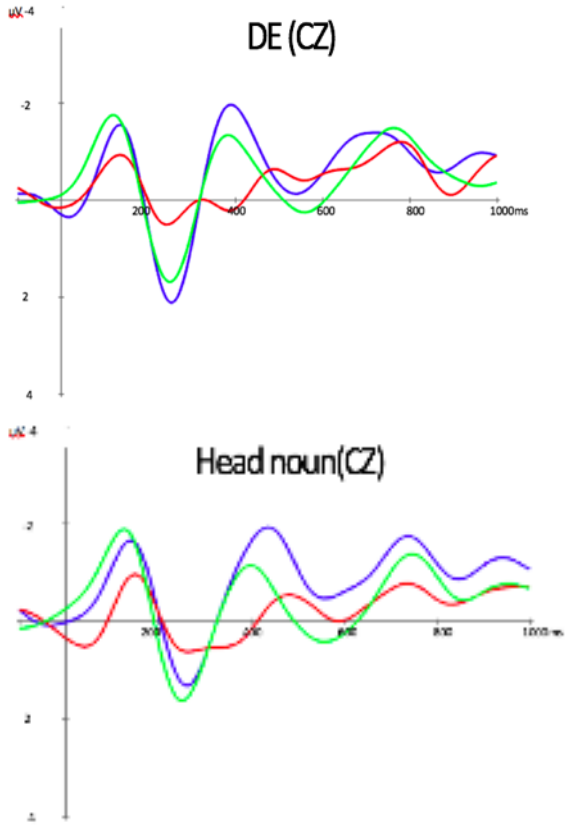


Figure 1. Grand averaged waveforms of three critical words in DO-bias, SC bias, and EQ-bias conditions.

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Croatian Conjunct Agreement Preferences Disambiguate Relative Clause Antecedent

Jana Willer Gold, Anita Peti-Stantic, Marijan Palmovic, and Ana Matic

The experimental advances into the attachment site of relative clauses (RC) headed by a complex NP have attested both HA and LA preference in typologically diverse languages. While it has been shown that structural properties within a language and experimental design itself have an effect on attachment preferences (e.g. Frazier & Clifton 1996, Hemforth et al. 1998, Hemforth et al. 2015), the investigations into the HA+LA languages have further fortified the efforts to relate the (residue of) cross-linguistic variation to the availability of certain language inherent properties such as the optionality in prosodic phrasing posited for Croatian (Lovrić and Fodor 2000, Lovrić 2003) or the availability of pseudo-relatives for Italian (Grillo and Costa, 2014). To expand the list of language-specific attachment height predictors, we ran a questionnaire and an eye-tracking study exploiting the syncretic form of the relative pronoun and the three-way conjunct agreement potential in Croatian.

Similar within-language variation in preferences with respect to *agreement* height has been observed for conjunct agreement (CA) in South Slavic languages (e.g. for Slovenian Marušič et al. (2015), for BCS and Slovenian Willer-Gold et al. (2016, 2018)), where predicate has been shown to agree in Gender+Number (G+N) with the hierarchically higher conjunct, the linearly closer conjunct and the entire conjunction phrase. Even with the same structural configuration and the same set of features undergoing valuation, CA and RC agreement are distinguished by the coindexation. In RC, the morphological marking on the relative pronoun points to its antecedent, hence the two have to be co-indexed. In CA, irrespective of the morphological marking on the predicate, the semantically valid subject can *only* be the entire conjunction phrase (c.f. Link-Agree in Marušič et al. 2015). Consequently, while in, for example, CA linear agreement exponent is purely morphological and carries no interpretative component, the opposite is predicted to hold for LA RC.

Current study is designed to test two hypotheses: (i) the three-way potential attested in the experimental literature for conjunct agreement can serve as a predictor of attachment preferences in RC; and, if confirmed (ii) the independently available underlying mechanics of agreement (a) constrains the attachment potential and, hence, (b) facilitates the RC interpretation. To achieve the stated research objectives we focus on RC headed by coordinated phrase in Croatian and capitalise on language-inherent property to morphologically mark the G+N values on the complementiser, spelled-out as the relative pronoun. In the experimental study, the RC was headed by a conjunction of two human masculine singular nouns in subject position. A violation paradigm manipulated the RC internal properties crossing *pronoun case* [nominative, accusative] and *predicate number* [singular, plural] to design a single set of materials. These were tested by two complementary methodologies: an offline questionnaire [exp1] to attest *attachment preferences*, (i), and an online eye-tracking study [exp2] to detect *processing difficulties*, (ii). Participants were Croatian native speakers, university students of comparable demographics.

The questionnaire results (n=30) replicate three-way attachment potential observed for CA in *Ambiguous* condition. In the remaining three conditions favouring single antecedent, the results show the overall preference for LA and the lack of HA in the *Case mismatch* condition (Figure 1). The results of the eye-tracking experiment (n=30) consistently show processing difficulty arising in late measures at the relative pronoun region |rel.pro+∅/cl+aux|, taking longer to read sentences with the *Ambiguous* and the *Ungrammatical* condition [tfd: t: 1.919, t: 1.970; N of

fix: t: 1.729, t: 1.946 (Figure 2 and Figure 3); and, N of reg: t: 1.795 with the *Ungrammatical* condition]. In addition, the main effect of the *pronoun case* and the *predicate number* has been observed for the late measures [tfd: t: 1.919, t: 1.970; N of fix: t: 1.729, t: 1.942; for *predicate number* N of reg: t: 1.795].

We contend that while processing difficulties in reading observed with the *Ungrammatical* condition are expected under standard violation paradigm, processing difficulties that arose with the *Ambiguous* condition can be taken as indications of disambiguation under (parallel) processing of multiple available agreement strategies (Hwang and Kaiser 2014) thereby creating the environment for the three-way attachment potential. Consequently, our research provides further support for language-independent investigations into RC (Betancort et al. 2009), contributes to the expanding experimental work on South Slavic conjunct agreement and challenges theories of agreement to be further refined in terms of the unvalued referential index feature (c.f. [ID] - Arregi and Hanink to appear).

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Sample experimental sentences:

a. *Ambiguous*

otac	*i*	*sin*	*koji*	*su*	*ga*	*vodili*
father.masc.sg.nom.	and	son.masc.sg.nom.	who.masc.sg./pl.nom.	aux.pl.	cl.masc.sg.acc.	took.masc.pl.

'The father and the son who took him.'

b. *Case mismatch*

otac	*i*	*sin*	*kojega*	*su*	*pro*	*vodili*
father.masc.sg.nom.	and	son.masc.sg.nom.	who.masc.sg.acc.	aux.pl.	∅-masc.sg.nom.	took.masc.pl.

'The father and the son whom they took.'

c. Number mismatch

otac	*i*	*sin*	*koji*	*ga*	*je*	*vodio*
father.masc.sg.nom.	and	son.masc.sg.nom.	who.masc.sg./pl.nom.	cl.masc.sg.acc.	aux.sg.	took.masc.sg.

'The father and the son who took him.'

d. Ungrammatical

otac	*i*	*sin*	*kojega*	*pro*	*je*	*vodio*
father.masc.sg.nom.	and	son.masc.sg.nom.	who.masc.sg.acc.	∅-masc.sg.nom	aux.sg.	took.masc.sg.

'The father and the son whom he took.'

Question:

tko	*je*	*koga*	*vodio*
who.nom	aux.sg.	who.acc	took.masc.sg.

'Who took whom?'

Figure 1

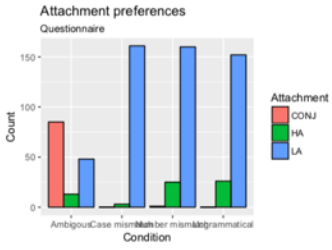


Figure 2

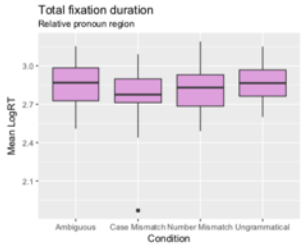
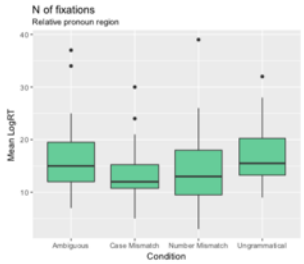


Figure 3



The syntax-semantics interface during sentence processing: ERP evidence on relative clause attachment ambiguity in Greek

Olioumtsevits, K.[1], Popov, S.[2]
[1]Aristotle University of Thessaloniki, [2]University of Groningen

The present study investigates the resolution of relative clause attachment ambiguity. Although it is one of the most studied types of syntactic ambiguity, studies on the subject have often neglected one important variable in on-line sentence processing and disambiguation, namely that of semantics (Tanenhaus & Trueswell, 1995). In order to bridge this gap in the literature, the focus here is on the role of semantics, and specifically, the nature of the interplay between semantic sources and structural preferences during relative clause attachment processing.

Twenty-four adult native speakers of Greek participated in the experiment, in which electrophysiological data was recorded. In the experimental stimuli, two potential antecedents were in the form of either a possessive construction or a prepositional *with*-phrase. The relative clause disambiguation was triggered by lexicosemantic cues.

Our results revealed the presence of the N400 effect (a component indicative of processing difficulty in semantic integration; Kutas & Federmeier, 2011) only in sentences with a possessive construction. No P600 effect was elicited in either of the conditions (a component indicative of syntactic processing difficulty; Kaan, 2007).

The findings suggest that structural preferences can be completely eliminated by the rapid influence of semantic cues, highlighting that syntax does not have *a priori* precedence over other sources of information when a structural ambiguity is encountered. In turn, the rather specific difficulty in semantic congruity seems to be associated with the different semantics of the two constructions in question (Langacker, 1993; Lehmann & Shin, 2000). Consequently, the results indicate that the processing strategy depends on the linguistic environment imposed by the disambiguation frame; semantic (and not syntactic) properties of the antecedent type are taken into account when the parser is enforced to form a semantic "agreement".

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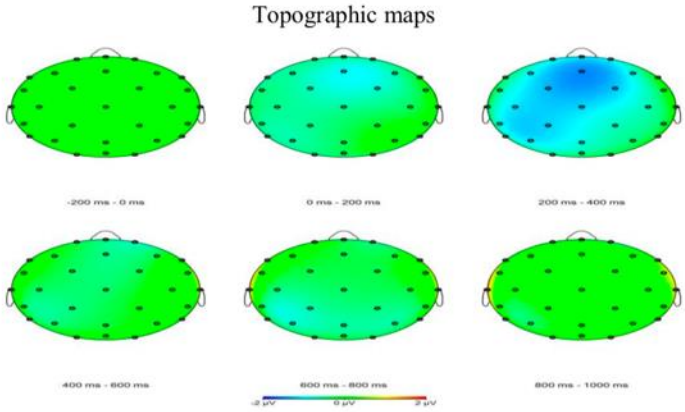

Figure 1. The topographic maps depict differences between high and low attachment sentences for the genitive condition.

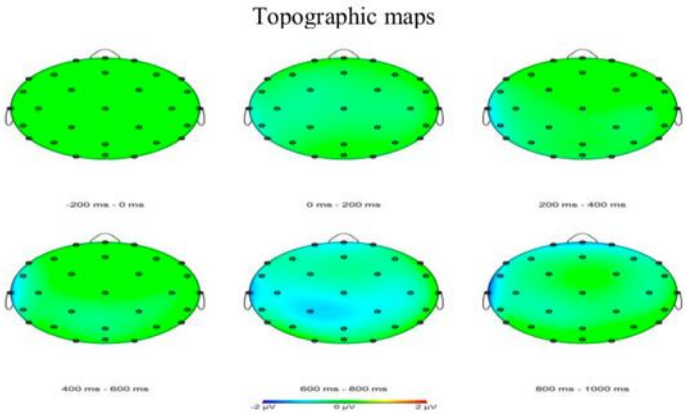

Figure 2. The topographic maps depict differences between low and high attachment sentences for the prepositional phrase condition.

SESSION 4

Vowel Perception in Congenital Amusia

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Background

Congenital amusia is a disorder that negatively influences pitch and rhythm perception (e.g. Peretz et al. 2002) and is not caused by a hearing deficiency, brain damage or intellectual impairment. While congenital amusia had long been reported to affect only the musical domain (Ayotte et al. 2002; Peretz et al. 2002), several studies have shown that amusics also have impaired perception of intonation (e.g. Patel et al. 2008) and linguistic tones (e.g. Tillmann et al. 2011), both mainly relying on pitch cues.

Aims

In the present study we aimed to show that congenital amusia also has an influence on linguistically relevant cues other than pitch by looking at the perception of the German front high vowels /ɛ/, /ɛ:/, /e/ and /e:/. These vowels are differentiated by length as well as formant frequency and we assessed amusics' behavioral and electrophysiological responses, more specifically the Mismatch negativity (MMN), which is a component evoked by unconscious change detection in the auditory signal.

Method

We tested 11 congenital amusics diagnosed with of the Montreal Battery of Evaluation of Amusia (Peretz et al. 2003) and 11 controls matched for age, gender, education and musical training. All participants were right handed, had normal hearing and had German as their native language.
Our stimuli were four isolated synthetic vowels, /ɛ/, /ɛ:/, /e/ and /e:/, created by Klatt synthesis in Praat (Boersma & Weenink 2016), varying in either duration or spectral properties, based on the properties of natural German vowels.
For the behavioral study, we employed an ABX task and the stimuli were presented with an inter-stimulus interval (ISI) of either 0.2 s or 1.2 s.
For the EEG study, the stimuli were presented in a multi-deviant oddball paradigm in 4 blocks. In each block, one vowel was the standard and occurred 85% of the time, while the other three vowels served as deviants, each occurring 5% of the time. This resulted in 16 event-related potentials (ERPs) per participant: 4 standards and 12 deviants.

Results

Behavioral results: We calculated a linear mixed model with subject as random effect. We found main effects of group $t(20) = 2.26$, $p = 0.035$, ISI $t(2436) = 5.73$, $p = 0.000$ and cue $t(2436) = 4.60$, $p = 0.000$. Amusics performed worse than controls, the short ISI was overall harder and duration was overall harder than formant cues.

We used a linear mixed model for the MMN data as well. We found significant main effects for group $t(323.7) = -2.45$, $p = 0.024$ with amusics (M = -2.68) overall having a smaller MMN than controls (M= -3.37). In addition we found a main effect for cue $t(2351.8) = -6.05$, $p = 0.000$.

Conclusions

Our study shows that congenital amusia does not only affect pitch perception in language but also vowel perception, therefore having more far reaching consequences for speech perception than previously assumed. Not only was the behavior of amusics shown to be affected, we also showed differences in the MMN, reflecting differences in early auditory change detection.

Keywords

Congenital amusia, vowel perception, EEG, duration

N400 evidence that mismatch detection is sensitive to the phonetics but not the phonology of Mandarin tones

Stephen Politzer-Ahles, Jueyao Lin, & Lei Pan - The Hong Kong Polytechnic University

The present study tested whether abstract linguistic knowledge modulates the neural response to sounds. Hearing a sound that doesn't match one's expectation elicits a greater N400 than a sound that does match one's expectation (Malins & Joannisse, 2012, among others). We examine whether this N400 effect is attenuated when the sound heard has an abstract morpho-phonological relationship with the expected sound. To do so, we focused on tone alternation in Mandarin Chinese. Some Mandarin lexical tones undergo phonological changes; particularly, Low tone changes into Rising in some contexts. For instance, the character 使 is normally pronounced *shi*^{L}, but in the compound word 使者 ("envoy", *shi*^{R} *zhe*^{L}) it is pronounced with

Rising tone. Thus, hearing a syllable with Rising (e.g., *shi*^{R}) when one expects it in Low tone (e.g., *shi*^{L}) might not engender a serious mismatch, since *shi*^{R} is a legal variant of *shi*^{L}. On the other hand, the reverse should not apply: hearing *shi*^{L} when *shi*^{R} is expected should engender a mismatch, because there is no context in standard Mandarin where a Rising tone can change to a Low, and thus Low is simply the wrong tone. We report data from two pre-registered high-power ERP studies testing whether phonological derivability attenuates the N400 as described above.

In Experiment 1 (https://osf.io/a5beh/), N=80 native Mandarin speakers heard single syllables, each preceded by a character whose pronunciation either matches that syllable, totally mismatches it (unrelated to the syllable in both segments and tones), mismatches its tone but has a morphological relation (i.e., has a different tone but one that is related to the target tone through tonal alternation), or mismatches its tone and has no morphological relationship with the target. See Table 1 for examples. Experiment 2 (N=20 out of a planned 80; https://osf.io/c8qv9/) was the same, except critical heard targets were the first syllable in a nonce compound word, to make sure they were in contexts that phonologically license the tonal alternation. Both experiments included fillers to make the critical targets unpredictable, and participants judged whether the targets matched the previously seen characters.

Results are shown in Figures 1 and 2. All three mismatch conditions elicited robust N400s relative to the match condition, but in neither experiment was the N400 for the morphologically related mismatch attenuated relative to the N400 for the morphologically unrelated mismatch. (An earlier component showed this pattern in Experiment 1, but only when hearing Low tone, not when hearing Rising tone; this is opposite the direction predicted.) As the effects were not even in the direction expected, we don't report the statistical results here.

The findings suggest that abstract phonological knowledge does not influence the recognition or matching process that generates the N400 (see also Nieuwland et al., 2018), i.e., at this stage of recognition the listener apparently only attends to the surface form of the stimulus, and does not consider different underlying forms that it may derive from. It is possible that effects of abstract phonological knowledge could come into play at a later stage of processing, or a stage of processing that the present experimental design was unable to isolate or observe. E.g., outside of phonetics/phonology, there have already been suggestions that the N400 is only

sensitive to certain types of information when sufficient processing time is allowed (Chow et al., 2018). Whether this accounts for the present results remains to be tested in future study.

Table 1. A sample stimulus set for hearing the target *shi*. Participants first saw one of the characters (pronunciation of the character is indicated in parentheses), and then heard either *shi*^{L} or *shi*^{R}.

	T3 target: *shi*^{L}	T2 target: *shi*^{R}
Match	屎 (*shi*^{L})	食 (*shi*^{R})
Morphologically related mismatch	食 (*shi*^{R})	屎 (*shi*^{L})
Morphologically unrelated mismatch	士 (*shi*^{Falling})	士 (*shi*^{Falling})
Total mismach	厌 (*yan*^{Falling})	厌 (*yan*^{Falling})

Figure 1. ERPs at Cz from Experiment 1 (N=80), relative to syllable onset.

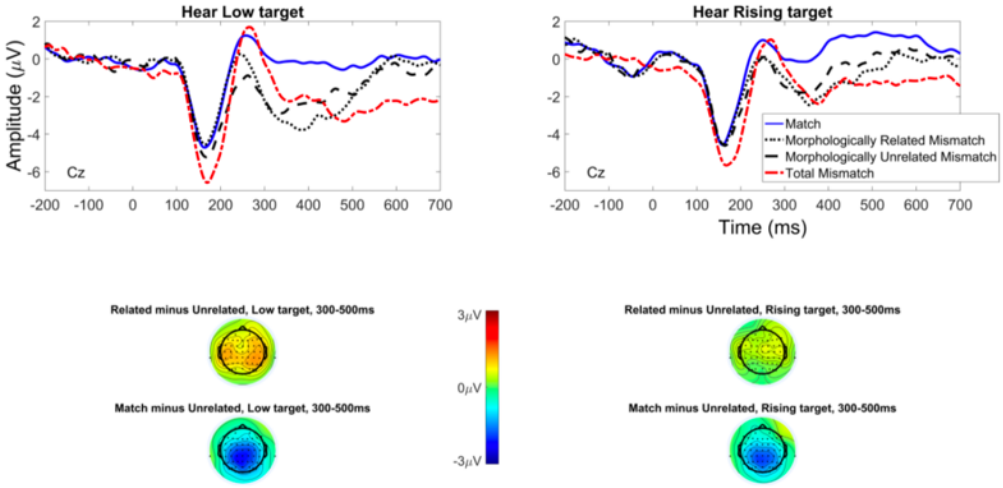
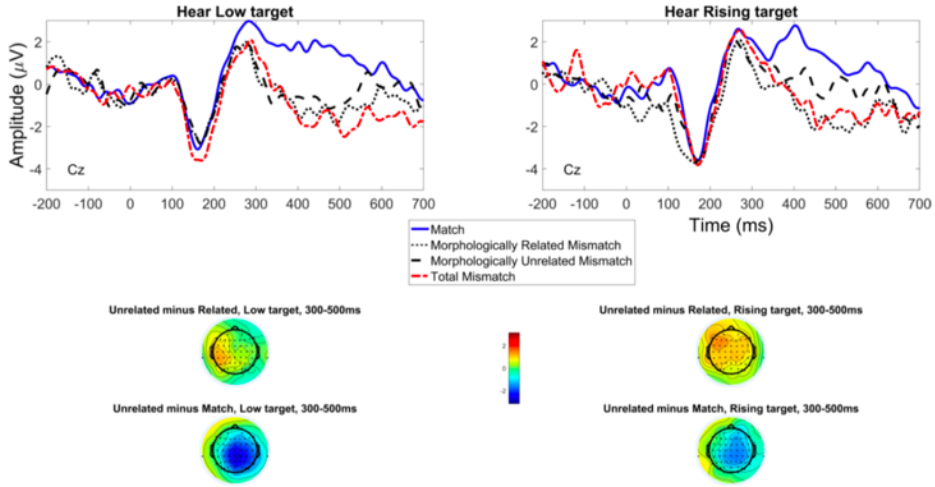


Figure 2. ERPs at Cz from Experiment 2 (N=20 out of a planned 80).



Tracking What the Eyes Hear: An Eye Tracking Study on Phonological Awareness

Alexandra Marquis, Meera Al Kaabi, Tommi Leung, & Fatima Boush United Arab Emirates University

Phonological Awareness is the ability to perceive and manipulate the sounds of spoken language (Goswami & Bryant, 1990; Holm, Farrier, & Dodd, 2008). It is a strong predictor of reading and literacy skills in children (Holm et al., 2008; Melby-Lervåg, Lyster, & Hulme, 2012). This study is a follow-up investigation to a behavioral study conducted on phonological skills of first grade Emirati children (Marquis, 2016-2018). We formulated the following hypotheses: (1) average fixation duration and count will vary according to the three experimental conditions, (2) explicit instructions will facilitate phonological awareness and therefore yield shorter and fewer average fixations than implicit instructions, (3) performance on the Rhyme Matching task will be impeded in comparison to the consonant tasks, and (4) feedback will facilitate overall performance.

The current study used the eye-tracking methodology to follow and measure the allocation of visual attention of sixty Emirati Arabic speaking adults while they completed a simple, computer-delivered visual world paradigm task on phonological awareness skills, containing noun stimuli selected from the Emirati Arabic Language Acquisition Corpus (EMALAC, Ntelitheos & Idrissi, 2017). Participants were assigned to either Feedback or No Feedback group (30 for each group). Each trial began with a script introducing a character whose name served as a prime for the target phoneme. This was followed by a display with four possible noun choices depicted as cartoon images, including the target noun and three distractors (see Figure 1). Three phonological conditions were used: 1. explicit instructions for Onset Consonant Matching (OCM), 2. implicit instructions for Segmentation of Initial Consonant (SIC), and 3. Rhyme Matching (RM). In total, there were 12 trials for each condition, in addition to four practice trials for each condition (not included in the analyses). Participants were asked to listen to each script, look at the given images and record their answers by clicking on the image of their choice.

A multivariate analysis of variance (MANOVA) was performed to analyze the data. We found significant main effects of Phonological condition ($p < 0.001$) and a marginally non- significant interaction effect ($p = 0.050$). There was no significant effect of administering feedback. Univariate tests showed that data on average length and number of fixations to target, average visits to the target, and response accuracy were significantly different for the different phonological conditions, and that the interaction was significant for average fixations to the target.

These results indicate that participants' gaze indices differ according to the different phonological manipulations, and that feedback does not affect performance.

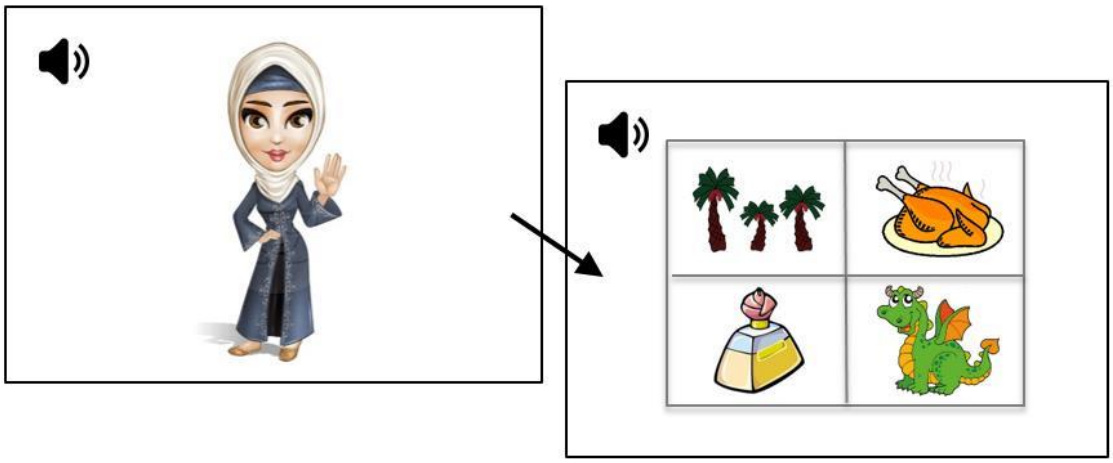


Figure 1.

Example of a trial.

Screen 1: هذي لؤلؤ. لؤلؤ تحب الأشياء الي تشابه اسمها. شو من هاي الأشياء لؤلؤ تحب؟ ‘This is Lulu. Lulu likes things that sound like her name. Which of these things is the one that Lulu likes?’ Screen 2: 1. أب [ʔubuu: 2.مطر ,’mətˁar] ‘rain[3.دنيا .4 & ’dənya] ‘world[منز [’mənaz] ‘cradle[‘father’ (target), and distractors[

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