Language Acquisition

ISSN: 1048-9223 (Print) 1532-7817 (Online) Journal homepage: http://www.tandfonline.com/loi/hlac20

Beyond the scope of acquisition: A novel perspective on the isomorphism effect from Broca's aphasia

Lynda Kennedy, Jacopo Romoli, Lyn Tieu, Vincenzo Moscati & Raffaella Folli

To cite this article: Lynda Kennedy, Jacopo Romoli, Lyn Tieu, Vincenzo Moscati & Raffaella Folli (2018): Beyond the scope of acquisition: A novel perspective on the isomorphism effect from Broca's aphasia, Language Acquisition, DOI: 10.1080/10489223.2018.1502772

To link to this article: https://doi.org/10.1080/10489223.2018.1502772

Published online: 05 Sep 2018.

LANGUAGE ACQUISITION
https://doi.org/10.1080/10489223.2018.1502772

Routledge
Taylor & Francis Group

Beyond the scope of acquisition: A novel perspective on the isomorphism effect from Broca's aphasia

Lynda Kennedy[a], Jacopo Romoli[a,b], Lyn Tieu[b,c], Vincenzo Moscati[d], and Raffaella Folli[a]

[a]Ulster University; [b]Macquarie University; [c]Western Sydney University; [d]University of Siena

ABSTRACT

Children have been reported to prefer the surface scope or "isomorphic" reading of scopally ambiguous sentences (Musolino 1998, among others). Existing accounts in the literature differ with respect to the proposed source of this *isomorphism effect*. Some accounts are based on learnability considerations (e.g., Moscati & Crain 2014), while others invoke pragmatic and/or processing factors (e.g., Gualmini et al. 2008; Musolino & Lidz 2006). The present study investigates whether the isomorphism effect is specific to development or rather is observable in other populations with language processing limitations. We investigated the interpretation of ambiguous sentences containing "every" and negation in 4–6-year-old children, individuals with Broca's aphasia, and neurotypical adult controls. We observed parallel performance in the children and the aphasic group, with both groups accessing more surface scope readings than inverse scope readings. This finding suggests that the preference for isomorphism may not be specific to acquisition and supports accounts that are not specifically based on learnability considerations—for example, processing accounts along the lines of Musolino & Lidz (2006).

ARTICLE HISTORY
Received 16 may 2016
Accepted 18 may 2018

1. Introduction

Sentences containing logical operators such as negation and quantifiers can be scopally ambiguous, giving rise to multiple interpretations depending on the relative scope of the logical operators. One particular case that has been the focus of much work in the acquisition literature involves sentences containing the quantifier "every" and negation (Musolino 1998; Gualmini, et al. 2008, and many others), as shown in (1):

(1) Every elephant didn't collect coconuts.
a. No elephant collected coconuts. *every > not*
b. Not every elephant collected coconuts. *not > every*

The sentence in (1) has two truth-conditionally distinct readings, paraphrased in (1a) and (1b). The reading in (1a), referred to as the *surface scope* reading, arises when the subject Noun Phrase (NP) takes wide scope above negation, while the *inverse scope* reading in (1b) arises when the subject NP is interpreted as taking scope below negation.[1] It has been observed that children and adults often differ in their interpretation of sentences containing "every" and negation (Musolino, Crain & Thornton 2000; Musolino & Lidz 2003). More specifically, in the absence of contextual or experimental manipulations, 4–6-year-old children tend to interpret sentences like (1) on their surface

CONTACT Lynda Kennedy la.kennedy@ulster.ac.uk School of Health Sciences, Ulster University, Shore Road, Newtownabbey BT37 0QB, UK

[1]A variety of theoretical approaches have been proposed to capture the distinct readings. One standard approach involves positing a covert movement operation that displaces elements at Logical Form (LF) (see, e.g., May 1977; Fox 2000). For present purposes, we remain neutral with respect to these theoretical details.

scope (SS) readings, whereas adults either show no preference or even prefer the inverse scope (IS) reading of such sentences (Musolino, Crain & Thornton 2000; Noveck, et al. 2007). Children's preference for surface scope has often been referred to as the *isomorphism effect* (Musolino, Crain & Thornton 2000).

In this article, we group together certain accounts that appeal either to pragmatic or processing factors to explain the observation of isomorphism and contrast them with accounts that are based on *learnability* factors that cannot naturally be extended to Broca's aphasia (or other adult populations).

The learnability-based account we consider here is the one presented in Moscati & Crain (2014), based on the Semantic Subset Principle. According to this account, children initially prefer the stronger (subset) reading of ambiguous sentences (Berwick 1985, among many others). The account is couched in terms of parameters: children are said to begin with the parameter setting that corresponds to the logically stronger of the two possible readings. For example, (1a) is logically stronger than (1b), as it asymmetrically entails it. Children are said to start with the stronger subset reading as this ensures learnability in the absence of negative evidence, which children are generally assumed not to receive. If children started with the weaker superset reading, this would create a learnability problem whereby children would never be exposed to evidence that they had the wrong parameter setting. What is relevant for our purposes is that there is no clear way in which one could extend a learnability-based account to aphasia, as it would require auxiliary explanations for why acquired language disorders would result in changes to parameter settings that are established during the language acquisition process.

Alternatively, certain pragmatic and processing factors have been argued to mediate the performance of children and adults on sentences like (1). For example, Gualmini et al. (2008) propose a pragmatic account based on the *Question-Answer Requirement* (QAR). They argue that the difference between children and adults lies in the understood Question Under Discussion (QUD) in the context (Roberts 2004). Children and adults access the readings of an ambiguous sentence that provide a good answer to the contextually defined QUD, with a good answer being one that entails either a positive or a negative response to the QUD (Gualmini et al. 2008). If the only reading that answers the QUD is false in a given context, adults, but not children, can accommodate a new question in order to access the alternative interpretation. Under this account, if children access fewer inverse scope readings than adults do in a given context, it is because the inverse scope reading does not adequately address the salient QUD in the given context.

An alternative account, which we will refer to as the *reanalysis* account, appeals to both pragmatic and processing factors. Musolino & Lidz (2006) argue that the observed difference between children and adults reflects a tension between a preference for true interpretations (*Principle of Charity*) and a parsing preference for surface interpretations. In (1), for example, the parser's preference will be for the interpretation on which "every" c-commands negation in the syntactic structure, following the surface position of these elements. While adults tend to prefer true readings, in line with the Principle of Charity, children are initially guided by syntactic parsing preferences for surface scope. When the initial default interpretation is not supported by the context, it must be *reanalyzed* to derive the intended interpretation. As children are reported to struggle with reanalysis (see, for example, Trueswell et al. 1999), such an account can explain why children may opt for false surface scope interpretations over true inverse scope interpretations. According to Musolino & Lidz (2006), pragmatic information can help children to override this default preference for surface scope and behave in a more adultlike manner.

The crucial feature of the pragmatic and processing accounts outlined previously is that they are not specific to the developmental process and can in principle be extended to other populations.

1.1. *Broca's aphasia and scope ambiguities*

A number of studies have examined how individuals with Broca's aphasia perform on so-called *complex* syntactic structures involving *overt* movement, that is, syntactic movement that has observable (phonological) consequences for the spellout of the moved elements (see Reinhart 1997;

Potsdam 2012). One major line of research has attempted to explain the poor performance that is observed for structures such as passives, relative clauses, and *wh*-questions (see Grodzinsky 2000; Grodzinsky & Amunts 2006). Some researchers have argued that there is an impairment affecting grammatical operations specifically (Grodzinsky & Amunts 2006), while others have appealed to more general limitations in processing ability (Caplan, Michaud & Hufford 2013).

In contrast to the focus on overt movement in this population, relatively few studies have examined *covert* movement, that is, movement that displaces elements *silently* at the level of Logical Form (May 1977, 1985), with consequences for the interpretation but not the phonological spellout of the sentence (though see Saddy 1995; Varkanitsa et al. 2016). Existing behavioral data indicate that performance on doubly quantified sentences is in line with that of typical adults, although reaction time results from Varkanitsa et al. (2016) indicate a murkier picture.

1.2. *The present study*

If we find that individuals with Broca's aphasia exhibit parallel behavior with children with respect to scopally ambiguous sentences, we will take this as evidence that we should seek a unified account of the isomorphism effect. This is relevant for the debate concerning isomorphism. On the one hand, any account based on considerations that are specific to acquisition cannot be straightforwardly extended to individuals with Broca's aphasia, as this would require a number of theoretically driven assumptions about the connection between language acquisition and language loss. It is unclear how to explain why language impairment as a result of Broca's aphasia would result in the "loss" of a particular parameter setting that under a learnability account is subject to maturation during language acquisition. An account based on *learnability* therefore does not predict any similarity between the performance of the two populations on scope ambiguity.

On the other hand, *processing limitation* explanations have been proposed to explain the behavior of both young children (Trueswell et al. 1999) and individuals with Broca's aphasia (e.g., Caplan et al. 2013), with some researchers appealing to such limitations to explain the performance of the two populations (Ruigendijk et al. 2011; Avrutin 2000). A processing limitation explanation could likewise provide a natural account of any observed parallels with respect to scope ambiguity.

2. Experiment

We designed an experiment to test the comprehension of negative universally quantified sentences in a group of 4–6-year-old children, a group of individuals with Broca's aphasia, and a group of neurotypical adults. We used a 3 x 2 design with Group (children vs. aphasic group vs. typical adults) and Condition (surface scope vs. inverse scope, within subject) as factors.

2.1. *Methods*

2.1.1. *Participants*

We tested sixteen 4–6-year-old children (4;00–6;11, $M = 5;03$), nine individuals with Broca's aphasia ($M = 53$) (hereafter BAs), and 16 typical adult controls (hereafter TAs). All participants were monolingual speakers of English. The child participants were recruited from local primary schools and had no history of hearing, visual, cognitive, or language impairment. BAs were recruited from Stroke NI and were selected on the basis of specific clinical diagnostic criteria.[2] All BAs showed performance patterns consistent with a diagnosis of agrammatic Broca's aphasia. All TAs were undergraduate students and had no history of cognitive or language impairment.

[2]These criteria consisted of: (i) assessment on the Western Aphasia Battery (WAB, Kertesz 1982); (ii) agrammatic speech production; and (iii) impaired comprehension of "syntactically complex" sentences on the Verb and Sentence Test (VAST, Bastiaanse et al. 2003).

2.1.2. *Procedure*

Participants completed a Truth Value Judgment Task (Crain & Thornton 1998), consisting of a series of short stories accompanied by cartoon images on a laptop computer. At the end of each story, the experimenter asked an explicit question (the QUD) about the story. A video of another researcher responding to the QUD was then played on the laptop, giving the illusion that the responder was participating live via webcam. The participant's task was to judge whether or not the sentence was a true description of the story. The task lasted around 20 minutes. Responses and justifications of the children and adult controls were recorded. BAs gave their responses non-verbally.

2.1.3. *Materials*

Participants were presented with two kinds of target sentences. These corresponded to *every-not* sentences presented in: (i) contexts consistent only with an inverse scope interpretation (hereafter the IS condition), as in Figure 1 (right), and (ii) contexts also consistent with the surface scope interpretation (hereafter the SS condition), as in Figure 1 (left). The contexts presented in the two target conditions were maximally similar, modulo the differences giving rise to the different truth conditions. Importantly, at least one of the readings of the target sentences was made true in the relevant contexts (for both SS and IS targets), such that participants could say *yes* in compliance with the Principle of Charity.[3]

All context stories began with four individuals (e.g., doctors, policewomen, animals) considering two possible activities to undertake. The stories were presented in this way to ensure felicity of the negative target sentences and to satisfy the *Condition of Plausible Dissent* (Wasow, 1972; Crain & Thornton, 1998). To illustrate, the characters in the story would begin by considering two potential activities, thus setting up a salient expectation that they could do either activity. At the end of the story, one of these options was abandoned, depending on the target reading (SS vs. IS). In the SS condition, the story ended with all of the characters deciding to do one activity, while in the IS condition, the story ended with half of the characters doing one activity and the other half doing the alternative activity. Example stories for the SS and IS conditions are provided in (2) and (3).

The stories preceding the two kinds of target sentences were identical in structure up to the end of the stories, when the researcher would ask the explicit QUD. The QUD used to prompt the test sentences was a polar question of the form, *Did NP1 V NP2?* This was kept consistent across the two conditions. Crucially, the negative test sentence was both true in the context and a good answer to

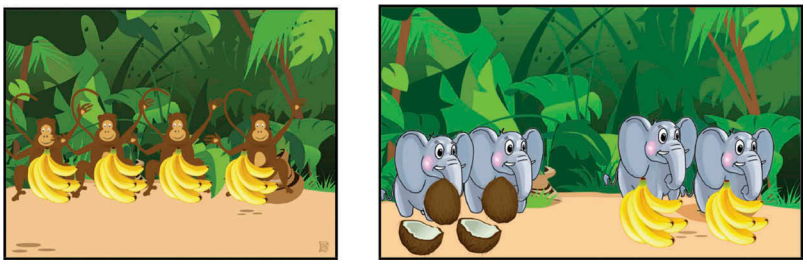

Figure 1. The image on the left is an example of an SS target, as it is compatible with both the surface and inverse scope readings of the sentence *Every monkey didn't collect sticks*. The image on the right is an example of an IS target, as it is compatible only with the inverse scope reading of the sentence *Every elephant didn't collect coconuts*.

[3]Note that the SS reading entails the IS reading; it was therefore not possible to present the items in a context that made the SS reading true but the IS reading false.

the QUD.[4] All target sentences were uttered using neutral intonation, without particular stress on the universal quantifier or negation.

(2) **Surface scope (SS) condition (Target: True)**
Context: *The monkeys are bored in the jungle. They can't decide what to do. They can collect sticks for the fire or they can collect bananas for lunch. In the end, all of the monkeys decide to collect bananas and not to collect sticks.*
QUD: Did every monkey collect sticks?
Test sentence: Every monkey didn't collect sticks.

(3) **Inverse (IS) condition (Target: True)**
Context: *The elephants are bored in the jungle and want to do something fun. They can collect coconuts or they can collect bananas. In the end, some elephants decide to collect coconuts and some elephants decide to collect bananas.*
QUD: Did every elephant collect coconuts?
Test sentence: Every elephant didn't collect coconuts.

Since reading type was a within-subject factor, and the SS and IS stories for any given target were designed to be identical up to the point of the outcome of the story, we varied the nouns in the two conditions, yielding two sets of contexts and target sentences. The verb was the same across the two conditions (e.g., *collect*), but the nouns were varied (e.g., elephants vs. monkeys, sticks vs. coconuts). In all, participants received 10 SS and 10 IS targets, which were presented in blocks; the order of the blocks was counterbalanced across participants.

In addition to the target items, each participant also received eight control trials, four involving clearly true or clearly false *every*-sentences without negation, e.g., *Every girl sang on the stage*, and four involving clearly true or clearly false negative sentences without the universal quantifier, e.g., *The girl didn't eat the banana*. These controls allowed us to ensure that participants could interpret both "every" and negation in isolation. Because half of the controls were associated with a *yes*-target and half with a *no*-target, they ensured that participants could both appropriately accept and reject such items in the relevant contexts. In addition to the eight controls, we included 12 unambiguous fillers that did not contain negation or a universal quantifier, e.g., *The lion wore the hat*. These were presented as answers to simple *wh*-questions about the relevant stories. Filler stories could be associated with either a *yes*- or a *no*-target and were selected on the basis of participants' responses to the scopally ambiguous targets. This allowed us to ensure an overall balance of *yes*- and *no*-responses, as well as to make sure that the participants were paying attention to the QUD. The controls and fillers were randomly dispersed among the target items.

2.2. Results

Participants had to provide the correct answer on at least 15 of the 20 control and filler trials (75% accuracy rate) in order to be included in the analysis; this criterion was decided before any testing began. All 37 participants passed and were included in the analysis. Figure 2 displays the proportion of *yes*-responses for the three groups across SS and IS conditions. A mixed effects logistic regression model was fitted to the data with Condition (SS vs. IS) and Group (children vs. BAs vs. TAs) as fixed effects, including random by-participant intercepts and random by-participant slopes for Condition. Comparisons of models with and without the fixed effects revealed a significant main effect of Group, $\chi^2(2) = 24, p < .001$, a significant effect of Condition $\chi^2(1) = 55, p < .001$, and no interaction between Group and Condition, $\chi^2(1) = 1.6, p < .45$.

The finding of an effect of Group but no interaction suggests that a unified account of the performance of children and the BA group is feasible. As can be seen in Figure 2, the significant effect of Condition was driven by the asymmetry between the SS and IS conditions in all three groups,

[4]An anonymous reviewer points out that while the IS reading of the test sentences provides a congruent answer to the QUD, the SS reading provides a stronger assertion that asymmetrically entails that congruent answer. Our goal was simply to ensure that both readings of the ambiguous test sentences constituted good answers to the explicit QUD (they both entailed a negative answer to the QUD). We leave to future study the role of strength and "relative" congruence of possible answers.

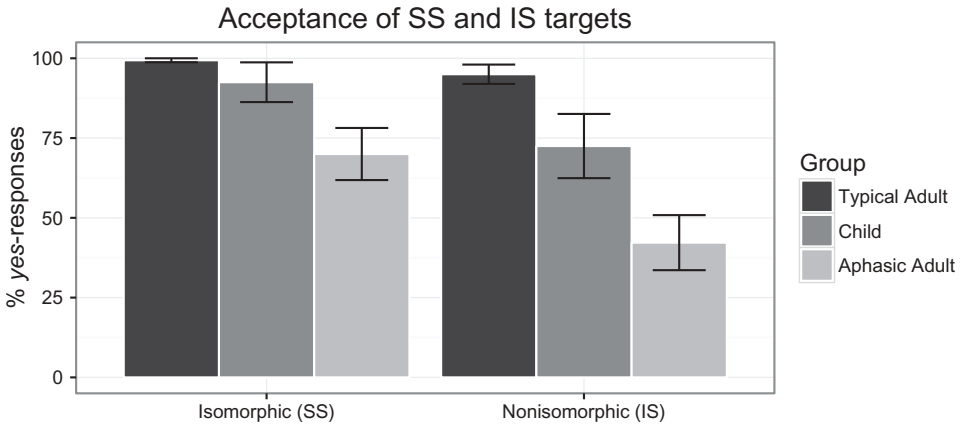

Figure 2. Percentage of *yes*-responses in the Isomorphic (SS) and Nonisomorphic (IS) conditions for all three groups.

with fewer *yes*-responses overall in the IS condition. Taken together, these results indicate that the so-called *isomorphism effect* is not an idiosyncracy of the developmental process but rather supports a unified account of the performance of the children and the BA group.

Recall that the SS and IS targets were associated with a *yes*-response. One might worry that participants could have displayed a *yes* bias driven by the Principle of Charity. However, two aspects of the results are reassuring in this respect. First, if the children or BAs responded on the basis of Charity, one might expect their performance to be more in line with that of the typical adults; yet both groups gave fewer *yes*-responses than the typical adults in both the SS and IS conditions. Second, the children's *yes*-responses were appropriately supported by their justifications. For example, children who accepted the SS target *Every cowboy didn't eat pizza* justified their responses by pointing out that all of the cowboys had chosen to do something else, e.g., "They all went on the horsies," "Every cowboy wanted to ride the horses," "They all rided horses." Children who accepted the IS target *Every teacher didn't play guitar* justified their responses by pointing out, e.g., "Some played guitar and some did singing."

3. Discussion

To summarize, the main aim of the current study was to investigate whether certain aspects of scope ambiguity resolution are specific to acquisition by comparing 4–6-year-old children with individuals with Broca's aphasia. The first main finding was that BAs and children showed a parallel pattern, preferring SS readings over IS readings. The first finding of parallel performance in children and BAs across conditions indicates that the so-called *isomorphism effect* is not unique to acquisition. As a learnability account (e.g., Moscati & Crain 2014) is based on factors specific to acquisition, this account cannot naturally explain the performance of BAs and children. On the other hand, a pragmatic or processing-based account can be extended to account for the performance of the two groups. The current findings suggest that we should seek a unified pragmatics/processing account of the difficulty displayed by the two populations. An advantage of a unified account is that it allows us to explain observed differences between language populations through differences in the operation of the parser, which is subject to both maturation and damage. In the following, we sketch a possible unified account of the performance of children and BAs based on the *reanalysis* account proposed in Musolino & Lidz (2006).[5]

[5]The QAR model (Gualmini et al. 2008) could in principle also be extended to account for the performance of the BA group. We observed, however, that even in the context of an explicit QUD (for which the target sentences were good answers), neither the children nor the BA group performed at the level of the typical adults. We leave to future research a more systematic manipulation of the QUD factor.

3.1. *Support for a unified account*

One existing account that can naturally explain the parallel performance observed in the children and the BA group is the *reanalysis* account presented in Musolino & Lidz (2006), inspired by models of incremental sentence processing (Trueswell et al. 1999). Much of the existing research on reanalysis in acquisition revolves around children's ability to recover from so-called garden-path sentences, which requires the revision of an initial interpretation of a structurally ambiguous sentence (e.g., Weighall 2008; Trueswell et al. 1999). Musolino & Lidz (2006) extend the investigation to scopally ambiguous sentences, drawing on both pragmatic factors and principles of incremental parsing to explain children's behavior. Let us briefly sketch how we might similarly account for the performance of individuals with Broca's aphasia.

Musolino & Lidz (2006) view relative processing difficulty and satisfaction of the Principle of Charity as competing forces in the interpretation of scopally ambiguous sentences: The greater the processing difficulty associated with a particular reading, the more likely that this difficulty will override the application of the Principle of Charity (see also Musolino & Lidz 2003). For an ambiguous sentence involving "every" and negation, the initial parse based on surface/lexical cues is the SS reading. This predicts acceptance on the SS reading in the relevant contexts. However, in a context compatible only with the IS reading, a potential "garden-path" effect may arise (Bever 1976; Frazier & Rayner 1982), whereby this initial parse is incompatible with the intended (IS) interpretation. In such a situation, the parse must be *reanalyzed* to recover the IS reading (Musolino & Lidz 2006). Given that reanalysis has been shown to be difficult for healthy adults (e.g., Christianson et al. 2006), it is unsurprising that, in the context of processing limitations, both children and BAs struggle with this process, resulting in a preference for the initial SS reading.

Support for a processing or reanalysis-based account can be found in existing studies of structural ambiguity, which suggest that reanalysis is hard both for children (see Trueswell et al. 1999; Omaki & Lidz 2015) and individuals with Broca's aphasia (see Novick, Trueswell & Thompson-Schill 2010; Yoo & Dickey 2014). The observed difficulty of reanalysis in these two populations has been attributed to domain-general cognitive control mechanisms: These are proposed to be immature in children (Davidson et al. 2006; Novick, Trueswell & Thompson-Schill 2005) and disrupted in Broca's aphasia (Novick, Trueswell & Thompson-Schill 2010). One advantage of such an account is that it may be able to explain both the uniformity and the differences observed in the performance of the two populations. Differences may lie in the nature or extent of the processing limitations in the two populations or in differences in their respective sensitivity to pragmatic/contextual manipulations. For example, existing work indicates that children successfully utilize lexical information in structural ambiguity resolution but are less sensitive to pragmatic information (see Trueswell et al. 1999). On the other hand, research on Broca's aphasia suggests that this population can effectively integrate pragmatic/contextual information during sentence processing (Nakano & Blumstein 2004).

While much further investigation is required to fully develop a concrete implementation of a unified account, our data from children and individuals with Broca's aphasia contribute clear empirical evidence in support of a processing-based account over learnability-based alternatives.

4 Conclusion

In this article, we have shown that individuals with Broca's aphasia and young children acquiring a first language access fewer inverse scope readings of scopally ambiguous *every-not* sentences than surface scope readings, and both groups access the two readings less often than typical adults. We argue that a unified processing account based on *reanalysis* could potentially explain the performance of both the children and the individuals with Broca's aphasia. The work here opens the door to much further research. For example, a natural future investigation in light of the data presented here would be to use online processing measures to determine whether there are observable real-time differences in the way that surface and inverse scope readings are

accessed by the different populations. More generally, the current study shows that fruitful insights can be gained by comparing different populations with respect to phenomena like scope ambiguity. Explanations for one group may not turn out to be easily applied to others, and the pursuit of a unified explanation may ultimately allow us to assess, compare, and decide between competing theories.

References

Avrutin, Sergey. 2000. Language acquisition and language breakdown: A comparative pycholinguistic approach. *Brain and Language* 71(1). 7–9.

Bastiaanse, Roelien, Susan Edwards, Edwin Mass & Judith Rispens. 2003. Assessing comprehension and production of verbs and sentences: The verb and sentence test (VAST). *Aphasiology* 17(1). 49–73.

Berwick, Robert C. 1985. *The acquisition of syntactic knowledge*. Cambridge, MA: MIT Press.

Bever, Thomas G. 1976. The influence of speech performance in linguistic structure. In Thomas G. Bever, Jerrold J. Katz & D. Terence Langendoen (eds.), *An integrated theory of linguistic ability*, 65–88. New York: Thomas Y. Crowell.

Caplan, David, Jennifer Michaud & Rebecca Hufford. 2013. Dissociations and associations of performance in syntactic comprehension in aphasia and their implications for the nature of aphasic deficits. *Brain and Language* 127(1). 21–33.

Christianson, Kiel, Carrick C. Williams, Rose T. Zacks & Fernanda Ferreira. 2006. Misinterpretations of garden-path sentences by older and younger adults. *Discourse Processes* 42. 205–238.

Crain, Stephen & Rosalind Thornton. 1998. *Investigations in Universal Grammar: A guide to research on the acquisition of syntax and semantics*. Cambridge, MA: The MIT Press.

Davidson, Matthew C., Dima Amso, Loren Cruess Anderson & Adele Diamond. 2006. Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia* 44(11). 2037–2078.

Fox, Danny. 2000. *Economy and semantic interpretation*. Cambridge, MA: MIT Press.

Frazier, Lyn & Keith Rayner. 1982. Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences. *Cognitive Psychology* 12. 178–210.

Grodzinsky, Yosef. 2000. The neurology of syntax: Language use without Broca's area. *Brian and Language* 23(1). 1–71.

Grodzinsky, Yosef & Katrin Amunts (eds.). 2006. *Broca's region*. New York: Oxford University Press.

Gualmini, Andrea, Sarah Hulsey, Valentine Hacquard & Danny Fox. 2008. The Question-Answer Requirement for scope assignment. *Natural Language Semantics* 16. 205–237.

Kertesz, A. (1982). Western aphasiabattery test manual. New York: Grune & Stratone.

May, Robert. 1977. *The grammar of quantification*. Cambridge, MA: Massachusetts Institute of Technology dissertation.

May, Robert. 1985. *Logical form: Its structure and derivation*. Cambridge, MA: MIT Press.

Moscati, Vincenzo & Stephen Crain. 2014. When negation and epistemic modality combine: The role of information strength in child language. *Language and Learning Development* 10(4). 345–380.

Musolino, Julien. 1998. *Universal Grammar and the acquisition of semantic knowledge*. College Park, MD: University of Maryland dissertation.

Musolino, Julien, Stephen Crain & Rosalind Thornton. 2000. Navigating negative quantificational space. *Linguistics* 38. 1–32.

Musolino, Julien & Jeffrey Lidz. 2003. The scope of isomorphism: Turning adults into children. *Language Acquisition* 11(4). 277–291.

Musolino, Julien & Jeffrey Lidz. 2006. Why children aren't universally successful with quantification. *Linguistics* 44. 817–852.

Nakano, Hiroko & Sheila E. Blumstein. 2004. Deficits in thematic integration processes in Broca's and Wernicke's aphasia. *Brain and Language* 88(1). 96–107.

Noveck, Ira, Raphaele Guelminger, Nicholas Georgief & Nelly Labruyere. 2007. What autism can reveal about *Every... not* sentences. *Journal of Semantics* 24. 73–90.

Novick, Jared M., John C. Trueswell & Sharon L. Thompson-Schill. 2005. Cognitive control and parsing: Reexamining the role of Broca's area in sentence comprehension. *Cognitive, Affective and Behavioural Neuroscience* 5(3). 263–281.

Novick, Jared M., John C. Trueswell & Sharon L. Thompson-Schill. 2010. Broca's area and language processing: Evidence for the cognitive control connection. *Language and Linguistics Compass* 4(10). 906–924.

Omaki, Akira & Jeffrey Lidz. 2015. Linking parser development to acquisition of syntactic knowledge. *Language Acquisition* 22. 158–192.

Potsdam, Eric. 2012. Backward raising. *Syntax* 15(1). 75–108.

Reinhart, Tanya. 1997. Quantifier scope: How labor is divided between QR and choice functions. *Linguistics and Philosophy* 20(4). 335–397.
Roberts, Craige. 2004. Context in dynamic interpretation. In Laurence R. Horn & Gregory Ward (eds.), *Handbook of pragmatics*, 197–220. Hoboken, NJ: Blackwell.
Ruigendijk, Esther, Sergio Baauw, Shalom Zuckerman, Nada Vasic, Joke de Lange & Sergey Avrutin. 2011. A cross-linguistic study on the interpretation of pronouns by children and agrammatic speakers: Evidence from Dutch, Spanish and Italian. In Edward Gibson & Neal J. Pearlmutter (eds.), *The processing and acquisition of reference*, 133–155. Cambridge, MA: MIT Press.
Saddy, J. D. 1995. Variables and events in the syntax of agrammatic speech. *Brain and Language* 50(2). 135–150.
Trueswell, John, Irina Sekerina, Nicole Hill & Marian Logrip. 1999. The kindergarten-path effect: Studying on-line sentence processing in young children. *Cognition* 73. 89–134.
Varkanitsa, Maria, Dimetrios Kasselimis, Andrew Fugard, Ioannis Evdokimidis, Judit Druks, Constantin Potagas & Hans Van de Koot. 2016. Syntactic predictions and asyntactic comprehension in aphasia: Evidence from scope relations. *Journal of Neurolinguistics* 40. 15–36.
Wasow, Thomas. 1972. *Anaphoric relations in English*. Cambridge, MA: Massachusetts Institute of Technology dissertation.
Weighall, Anna. 2008. The kindergarten path effect revisited: Children's use of context in processing structural ambiguities. *Journal of Experimental Child Psychology* 99(2). 75–95.
Yoo, Hyunsoo & Michael W. Dickey. 2014. Garden-path effects and recovery in aphasia. http://eprints-prod-05.library.pitt.edu/2562/1/517-952-2-RV%28Yoo-Dickey%29.pdf