On the Psycholinguistics of Argumenthood

by

Roxana Maria Barbu

A thesis submitted to the Faculty of Graduate and Postdoctoral
Affairs in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in Cognitive Science

Carleton University
Ottawa, Ontario

©2020
Roxana Maria Barbu

Abstract

Verbs are often understood in terms of the events they denote and the events' participants. These participants are typically classified as *core* or *peripheral* participants, which correspond to arguments and adjuncts, respectively. Consider *Cathy won the contest last year*. *Cathy* and *the contest* are core participants and arguments whereas *last year* is a peripheral participant and an adjunct, respectively. Despite an intuitive distinction between arguments and adjuncts, the exact nature of this distinction has been difficult to characterize.

This thesis contributes to our understanding of argument structure through two different approaches. We first conducted a cross-linguistic investigation of instrument phrases, which are notoriously difficult to characterize as arguments or adjuncts. This study revealed three factors that contribute to the controversial status of instruments: the semantics/syntax misalignment, the allow/require distinction, and the body-part/external instruments distinction.

Next we conducted an investigation of verbs and their participants in atypical populations. This study provided evidence that individuals with high functioning autism and individuals with loss of diagnosis may present with subtle argument structure impairments; proposed novel measures of language assessment that capture individ-

ual differences otherwise missed; and advocated for an alternative method of analysis that accounts for within-group variability.

Together, the two studies contribute to our understanding of some of the factors involved in distinguishing between arguments and adjuncts and highlight how argument structure concepts can be applied to better serve individuals with high functioning autism and with loss of diagnosis.

Acknowledgements

The privilege of successfully completing a PhD is a highly rewarding path, but make no mistake - its not an easy path nor is it my accomplishment alone. My experience was paved by the great sacrifices and contributions made by others.

This research would not have been possible without the many willing participants! A special thank you goes out to Sixto Vargas and his family who helped me with translations, recruitment and by being an amazing friend throughout the years. A significant portion of the work was made possible by Dr. Inge-Marie Eigsti's contribution who, though we have not met in person yet, has become a source of knowledge and guidance helping me make the bridge between theoretical and clinical linguistics. Thank you, Dr. Eigsti! Lara Russo contributed was both as a friend and as a researcher. The Turkish chapter would not have been possible without her hard work and dedication!

Immense gratitude goes to my committee, Dr. Kasia Muldner and Dr. Raj Singh. Dr. Muldner's contributions are many-fold: she instilled respect for stats, taught me subtleties often overlooked, and she asked the right questions to ensure my writing speaks to a Cognitive Science audience. Her dedication to students and passion for teaching are contagious. Being a TA for her class shaped my teaching style.

Dr. Singh noticed my passion for psycholinguistics and took me under his wing as I studied *assertions and presuppositions*. Throughout the years, I've greatly benefited from our discussions and his expertise in semantics and pragmatics. Without no doubt, he shaped my writing and reasoning process.

Dr. Ida Toivonen has been my role model from the moment I met her in Language and Cognition back in 2013. Dr. Toivonen imparted her knowledge very patiently - I was a Chemistry student with Linguistics as a hobby and had not written a paper that's not a lab report by then. She molded me with almost no starting materials. She guided me towards research that was rewarding intellectually but also dear to me such as *clitics in Romanian* and supported my passion for bridging theoretical and applied disciplines. Taught me how to write, how to present, how to give effective feedback and is my inspiration as a professor.

I could not have wished for better friends along the way. Ehsan Amjadian and Marly Mageau have been there from the start, being part of the motivation I needed to even embark on a PhD journey. Through thought-provoking conversations and sharing of knowledge, they helped shape me as a researcher! Cathy Agyemang and Chunyun Ma, there's no counting the stats/study sessions and proofreading rounds. Hooman Jazeby, your humour, trust and support lifted me up every time we chatted! Our friendship is an accomplishment I'll hold dear for many years to come! Omid Beiraghi and Adrian Taropa, from Kennedy into adulthood, we've grown together; when everything is changing, you stand still - that's family!

The Cognitive Science department played a large role into my upbringing as a researcher. Thank you to Kathy Van Benthem for imparting her EEG and python knowledge. One of the smartest and kindest people I've ever met! Thank you to Uzma

Khan and John Tracey, for insightful conversations, kind and encouraging words, and being there for us! Thank you to Sanda for extending her friendship! A special thank you goes out to May Hyde whose positivity and dedication to students is a constant reminder of how much I have to be grateful for, and also that we should not forget to give back whenever we can.

Finally, I would like to thank my family, without whose help none of this would have been possible. Teaching me to prioritize learning for as long as I remember and moving across the world into the unknown to facilitate my education are just a layer of the sacrifices Aurelia and Octavian Barbu have made to ensure my future. My little brother is nothing but a ray of sunshine bringing light on our faces every time he smiles, reminding us that the future is bright, and keeping us forever young. The future is yours, Daveyon!

I would like to thank my husband for saying *hi* to me in Physics class back in 2006 when English was still a barrier preventing me to verbally express myself both academically and personally, for holding my hand over 10 years ago, and never letting go. Thank you, Dana!

Contents

1	Introduction	3
1.1	Linguistic arguments	5
1.2	Mismatches between semantics and syntax	11
1.3	A note about terminology	16
1.4	Structure of the thesis	17
2	Background	19
2.1	The argument/adjunct distinction cross-theories	19
2.1.1	Interim summary	26
2.2	Psycholinguistic and neurolinguistic evidence	26
2.2.1	The argument/adjunct distinction	27
2.2.2	Number of arguments	30
2.2.3	The semantic/syntactic nature of argumenthood	33
2.2.4	Argument structure subtleties	35
2.2.5	Interim summary	38
2.3	Clinical evidence	38
2.3.1	The argument/adjunct distinction	38
2.3.2	Number of arguments	39

2.3.3	The semantic/syntactic nature of argumenthood	41
2.3.4	Interim summary	43
3	On instruments	44
3.1	Background	44
3.1.1	Defining instruments	45
3.1.2	Instruments: arguments or adjuncts?	51
3.1.3	Instruments and the allow/require distinction	60
4	Instruments cross-linguistically	64
4.1	Goals of the present study	66
4.2	The status of instruments in English	66
4.2.1	Methods	66
4.2.2	Results	70
4.2.3	Interim summary	82
4.3	The status of instruments in Romanian	82
4.3.1	Methods	83
4.3.2	Results	84
4.3.3	Interim summary	95
4.4	The status of instruments in Spanish	95
4.4.1	Methods	96
4.4.2	Results	97
4.4.3	Interim summary	109
4.5	The status of instruments in Turkish	109
4.5.1	Methods	110

4.5.2	Results	111
4.5.3	Interim summary	122
4.6	General cross-linguistic analysis	122
4.6.1	The validity of the experimental set-up	123
4.6.2	On ditransitivity	125
4.6.3	The syntactic status of instruments	128
4.6.4	The semantic status of instruments	130
4.6.5	Takeaways	138
5	Verbs and their arguments in typical and atypical groups	139
5.1	Background	139
5.2	Argument structure in autism	141
5.3	Goals of the present study	146
5.4	Methods	147
5.5	Results	148
5.6	Discussion	156
6	Exploring within-group heterogeneity	158
6.1	Background	158
6.2	Adolescents with Loss of Diagnosis	159
6.3	Goal of the present study	161
6.4	Group comparisons	162
6.4.1	Results	162
6.4.2	Discussion	167
6.5	K-means clustering	167

6.5.1	K-means clustering on ADOS measures	169
6.5.2	K-means clustering on argument structure measures	171
6.5.3	K-means clustering on the CELF measure	173
6.5.4	Discussion	174
7	Final remarks	175
	Appendix	179
A.	English version	180
B.	Romanian version	181
C.	Spanish version	184
D.	Turkish version	187
E.	Cross-linguistic ditransitivity	190
F.	Sample language production across groups (ASD, LAD, and TD) .	191

List of Figures

2.1	Sample stimuli adapted from Lee and Thompson (2011)	39
4.1	Participants by experiment and verb class	71
4.2	Class*experiment interactions for the number of linguistic participants	73
4.3	Mean rates of choosing instruments by experiment and class	77
4.4	Allow/require instruments in the semantic experiment	79
4.5	Allow/require instruments in the syntactic experiment	80
4.6	Participants by experiment and verb class	85
4.7	Class*experiment interactions for the number of participants	87
4.8	Mean rates of choosing instruments by experiment and class	91
4.9	Allow/require instruments in the semantic experiment	92
4.10	Allow/require instruments in the syntactic experiment	93
4.11	Participants by experiment and verb class	99
4.12	Class*experiment interactions for the number of participants	100
4.13	Mean rates of choosing instruments by experiment and class	105
4.14	Allow/require instruments in the semantic experiment	106
4.15	Allow/require instruments in the syntactic experiment	107
4.16	Participants by experiment and verb class	112

4.17	Class*experiment interactions for the number of participants	114
4.18	Mean rates of choosing instruments by experiment and class	118
4.19	Allow/require instruments in the semantic experiment	119
4.20	Allow/require instruments in the syntactic experiment	120
4.21	Allow/require instruments in the semantic experiment across languages	137
5.1	Production of verb types by group	150
5.2	Production of verb tokens by group	151
6.1	Scatter plots of all measures by group: tokens, args difference, CELF, and ADOS (communication, social, and repetitive behaviour).	166

List of Tables

3.1	% of instrument mentions in a semantic and a syntactic task	59
4.1	Speakers' age by experiment	67
4.2	Experiment 1 - eliciting speakers' semantic intuitions	69
4.3	Experiment 2 - eliciting speakers' syntactic intuitions	69
4.4	Adjunct mentions by experiment	70
4.5	Number of participants by experiment and by verb class	74
4.6	Mentions of participants by experiment in transitive verbs	74
4.7	Mentions of participants by experiment in ditransitive verbs	74
4.8	Number of participants by experiment, by verb class	75
4.9	Mentions of participants by experiment in allow and require verbs . .	76
4.10	Mentions of instruments in require/allow and indirect objects in di- transitives in the syntactic experiment	81
4.11	Mentions of instruments in require/allow and indirect objects in di- transitives in the semantic experiment	82
4.12	Speakers' age by experiment	83
4.13	Adjunct mentions by experiment	84
4.14	Number of participants by experiment and by verb class	88

4.15	Mentions of participants by experiment in transitive verbs	88
4.16	Mentions of participants by experiment in ditransitive verbs	88
4.17	Number of participants by verb class and experiment	89
4.18	Mentions of participants by experiment in allow and require verbs . .	90
4.19	Mentions of instruments in require/allow and indirect objects in di- transitives in the syntactic experiment	94
4.20	Mentions of instruments in require/allow and indirect objects in di- transitives in the semantic experiment	94
4.21	Speakers' age by experiment	96
4.22	Adjunct mentions by experiment	97
4.23	Number of participants by experiment and by verb class	101
4.24	Mentions of participants by experiment in transitive verbs	101
4.25	Mentions of participants by experiment in ditransitive verbs	102
4.26	Number of participants by verb class and experiment	102
4.27	Mentions of participants by experiment in allow and require verbs . .	103
4.28	Mentions of instruments in require/allow and indirect objects in di- transitives in the syntactic experiment	108
4.29	Mentions of instruments in require/allow and indirect objects in di- transitives in the semantic experiment	108
4.30	Speakers' age by experiment	110
4.31	Adjunct mentions by experiment	111
4.32	Number of participants by experiment and by verb class	115
4.33	Mentions of participants by experiment in transitive verbs	115
4.34	Mentions of participants by experiment in ditransitive verbs	116

4.35	Number of participants by verb class and experiment	116
4.36	Mentions of participants by experiment in allow and require verbs . .	117
4.37	Mentions of instruments in require/allow and indirect objects in di- transitives in the syntactic experiment	121
4.38	Mentions of instruments in require/allow and indirect objects in di- transitives in the semantic experiment	121
4.39	Direct Object Mentions by Language and Experiment	124
4.40	Proportions of direct and indirect objects by language and experiment	125
4.41	Mentions of Direct and Indirect Objects	126
4.42	Mentions of direct and indirect objects proportions	127
5.1	Verb types by group	149
5.2	Verb tokens by group	150
5.3	Number and frequency of verb types by group	152
5.4	Produced and expected number of arguments by group	153
5.5	Argument structure completion	155
6.1	ANOVA/the Kruskal–Wallis test for tokens	162
6.2	Pairwise comparisons (p -values) for ‘all verbs’	163
6.3	Pairwise comparisons (p -values) for CELF	163
6.4	CELF scores by group	164
6.5	Pairwise comparisons (p -values) for ADOS	164
6.6	Clustering for ADOS measures	170
6.7	Clustering for all verbs	171
6.8	Clustering for expected arguments	172

6.9	Clustering for CELF	173
-----	-------------------------------	-----

Chapter 1

Introduction

The sentence in (1) represents a *giving* event:

- (1) Aura gave a yellow dress to Mary last summer at the beach.

The participants involved in the event are ‘Aura’, ‘a yellow dress’, ‘Mary’, ‘last summer’, and ‘at the beach’. It seems intuitively clear that ‘Aura’, ‘a yellow dress’, and ‘Mary’ are more important participants of the giving event than ‘last summer’ and ‘at the beach’.

There are many types of participants that can be present in events, but not all participants are equally important. Giving requires a giver, something that is given, and a receiver, denoted in (1) by ‘Aura’, ‘a yellow dress’, and ‘Mary’. These core participants are referred to as *arguments*. On the other hand, ‘last summer’ and ‘at the beach’ provide additional information and are optionally expressed in the linguistic string. These peripheral participants are referred to as *adjuncts*.

The argument/adjunct distinction has a rich literature dating back to the 5th or 6th century B.C. (Kak, 1987; Staal and Staal, 1972). With supporting evidence from

cross-linguistic (Tesnière, 1959; Creissels, 2007; Ye et al., 2010; Goddard et al., 2016; Kudrnáčová, 2019, a.o.), psycho- and neuro-linguistic (Malyutina, 2015; Meltzer-Asscher et al., 2015; Wang et al., 2019; Sharpe et al., 2019; for a review, see Thompson and Meltzer-Asscher, 2014), and clinical studies (Lee and Thompson, 2011; Barbieri et al., 2019), the argument/adjunct distinction is widely assumed.

While the distinction is often straightforward, some phrases are notoriously difficult to characterize as arguments or adjuncts. Such phrases display characteristics of both arguments and adjuncts: benefactives (e.g., Toivonen, 2013), oblique themes (e.g., Rákosi, 2013), experiencers (e.g., Toivonen, 2012), passive agents (e.g., Asudeh and Giorgolo, 2012), event nominals possessives (e.g., Grimshaw, 1990) and instruments (e.g., Donohue et al., 2004). Chapters 3-4 of this thesis mainly focus on instrument phrases, such as ‘with a broom’ in (2):

(2) The child swept the floor with a broom.

The sentence in (2) describes a *sweeping* event. The participants involved in this event are ‘the child’, ‘the floor’, and ‘with a broom’. While ‘the child’ and ‘the floor’ are uncontroversial arguments, the status of ‘with a broom’ is unclear. The next section further explores the argument/adjunct distinction.

This thesis aims to augment our knowledge of the argument/adjunct distinction by pursuing two special cases. Firstly, it explores the cross-linguistic status of instruments. Secondly, it explores the production of arguments and adjuncts in two atypical populations.

1.1 Linguistic arguments

We began our discussion of the argument/adjunct distinction by distinguishing between core and peripheral participants. This basic way of distinguishing between arguments and adjuncts is what Needham and Toivonen (2011) call the *core participants test*. The test relies on the verb's meaning and on the speakers' intuition to distinguish between core and peripheral participants. It is often the case that core participants are arguments, and peripheral participants are adjuncts (Needham and Toivonen, 2011).

Similarly, Dowty (1982) and Koenig et al. (2002, 2003) propose semantic obligatoriness as a criterion for argumenthood. According to this criterion, a participant is an argument if it is obligatory to completely describe the action expressed by the verb (Dowty, 1982; Koenig et al., 2002, 2003). Koenig et al. (2002, 2003), however, argue that the semantic obligatoriness criterion is necessary but not sufficient. All events occur in a place and at a time. Thus, following the semantic obligatoriness criterion, time and location would be arguments, even though they are adjuncts by other criteria.

To address this, Koenig et al. (2002, 2003) propose specificity as an additional criterion for argumenthood: a phrase is an argument if and only if it is both semantically obligatory and specific to a verb or class of verbs. Since all events occur in a location and at a time, they fail the specificity test.

The core participants test is useful for outlining the general difference between arguments and adjuncts; however, it provides only part of the story. The argument/adjunct distinction, as pointed out by Bresnan (1995) and others, has two facets, semantic and syntactic. Arguments and adjuncts can be characterized sepa-

rately by their syntactic and their semantic features. Next, I review select textbook definitions highlighting these two facets.

Arguments are elements of a clause which have a close semantic relationship to their predicate. They are the participants which must be involved because of the very nature of the relation or activity named by the predicate, and without which the clause cannot express a “complete thought.” ... But speakers often need to convey other elements of meaning as well, elements which are not closely related to the meaning of the predicate but which are important to help the hearer understand the flow of the story, the time or place of an event, the way in which an action was done, etc. Elements of this type are not arguments; they are called ADJUNCTS. (Kroeger, 2005, p. 58)

Adjuncts are always optional, whereas complements¹ are frequently obligatory. The difference between them is that a complement is a phrase which is selected by the head, and therefore has an especially close relationship with the head; adjuncts, on the other hand, are more like ‘bolt-on’ extra pieces of information and don’t have a particularly close relationship with the head. (Tallerman, 2014, p. 98)

The relations between parts of a construction are all cast in terms of predicate-argument relations. For example, in *Heather sings*, *Heather* is the argument and *sings* is the predicate. The predicate-argument relation is symbolic, that is, both syntactic and semantic. Semantically a predicate is relational, that is, inherently relates to one or more additional

¹The term *complement* is often used to refer to syntactic arguments whereas the term *argument* is (often) used interchangeably between semantic and syntactic (Hwang, 2012).

concepts. In *Heather sings*, singing inherently involves a singer. The semantic arguments of a predicate are the concepts to which the predicate relates, in this case, Heather. Syntactically, a predicate requires a certain number of arguments in specific grammatical functions to it: *sing* requires an argument in the subject grammatical function. And syntactically, arguments are related to the predicate by a grammatical function: in this case, *Heather* is the subject of *sings*. (Croft and Cruse, 2004, p. 269)

Verbs are the glue that holds clauses together. As elements that encode events, verbs are associated with a core set of semantic participants that take part in the event. Some of a verb's semantic participants, although not necessarily all, are mapped to roles that are syntactically relevant in the clause, such as subject or direct object; these are the arguments of the verb. For example, in *John kicked the ball*, 'John' and 'the ball' are semantic participants of the verb 'kick,' and they are also its core syntactic arguments - the subject and the direct object, respectively. [...] The array of participants associated with verbs and other predicates, and how these participants are mapped to syntax, are the focus of the study of argument structure. (Bowerman and Brown, 2008, p. 1)

Even though these descriptions differ from each other in detail, they are similar in that the connection between the verb and its arguments is described as the main distinguishing factor between arguments and adjuncts. Semantically, arguments are closely related to the meaning of the verb, whereas adjuncts are not (Kroeger, 2005). Syntactically, arguments are more likely to be expressed in the linguistic string, whereas adjuncts are almost always optional (Tallerman, 2014). From hereon,

we will use the terms *semantic* and *syntactic* arguments to distinguish between the two. Croft and Cruse (2004) and Bowerman and Brown (2008) highlight the mapping between semantics and syntax, with the latter pointing out that not all semantic participants are mapped syntactically.

Definitions such as the ones above serve to classify verbs based on the number of arguments they take. Arguably, verbs take a maximum of three or four arguments (Tesnière, 1959; Kearns, 2011; Traxler, 2011). Examples (3-6) illustrate verbs with one to four arguments and further exemplify the argument/adjunct distinction.

(3) **One-argument verbs:**

- a. Daveyon laughed whenever his sister tickled him.
- b. *laughed whenever his sister tickled him.

Laughing takes one semantic argument: the person laughing, which is expressed in the linguistic string as ‘Daveyon’. The sentence marked by an asterisk (*; 3-b) illustrates that omitting an argument renders the sentence ungrammatical. The adjunct is *whenever his sister tickled him*. It provides information about the time of laughing. Other one-argument verbs include sleep, sneeze, die, and fall.

(4) **Two-argument verbs:**

- a. Tavi consumes energy drinks because he needs to stay awake all night.
- b. *Tavi consumes because he needs to stay awake all night.

Consuming takes two semantic arguments: someone consuming and something being consumed. These are expressed in the linguistic string as ‘Tavi’ and ‘energy drinks’. The adjunct is ‘because he needs to stay awake all night’. It provides the reason for

the consumption. Other two-argument verbs include love, kiss, smoke, and hug.

(5) **Three-argument verb:**

- a. Thai put the gifts under the tree quiet as a mouse.
- b. *Thai put the gifts quiet as a mouse.

Putting takes three semantic arguments: someone who puts, something that is put, and a place. These are expressed in (5) as ‘Thai’, ‘the gifts’ and ‘under the tree’. As you may recall, time and place are typically adjuncts. There are however, verbs for which location and time² are arguments. Such examples highlight the importance of the specificity criterion: though all events occur in a place, the location is closely tied to the meaning of the verb *to put*, thus, it is specific to it.

The adjunct is ‘quiet as a mouse’. It denotes the manner in which the putting took place. Other three-argument verbs include tell, give, order, pass, and call.

The examples reviewed so far show a perfect match between semantic and syntactic arguments. The next few examples illustrate cases where not all semantic arguments are obligatory in the linguistic string.

(6) **Four-argument verb:**

- a. The couple paid Miu \$60 for the tires.
- b. The couple paid \$60 for the tires.
- c. The couple paid for the tires.

Paying takes four semantic arguments: the person paying, the person being paid, the amount being paid, and the object paid for. All four participants are *conceptually* necessary to accurately describe a paying event. Consider the amount being paid. A

²The meeting lasted an hour.

scenario composed of only two people and an object, without the amount of money, would no longer describe a paying event. It would describe a giving/passing event.

These semantic arguments are expressed in example (6) by ‘the couple’, ‘Miu’, ‘\$60’, and ‘for the tires’. However, not all of these must be expressed in the linguistic string. Examples (6b-c) illustrate that the person being paid and the amount being paid could be omitted without affecting the sentence’s grammaticality. Other four-argument verbs include charge and transfer.

Some verbs such as *rent* take five semantic arguments (Apresjan, 1992):

(7) **Five-argument verb:**

- a. Dana rented an apartment from Mr. Guy for \$685 per month for one year.
- b. Dana rented an apartment.

Semantically, *renting* requires the landlord and tenant, the property being rented, the cost of renting, and the period of time. Any changes to the *semantic* set of participants would describe a different situation. For example, an event involving two people, a property, and a cost, without a period of time, would no longer describe a renting event. Instead, it would describe a buying/selling event. An event involving only two people and an object, without a period of time and a cost, would describe a giving/transferring event (Apresjan, 1992).

These semantic arguments are expressed in example (7) by ‘Dana’, ‘an apartment’, ‘from Mr. Guy’, ‘for \$685 per month’ and ‘for one year’. Similar to four-argument verbs, not all are obligatory in the linguistic string (7-b). Other examples of five-argument verbs include travel, dispatch, and lease.

Though cases illustrating a semantics/syntax alignment are insightful (3-5), per-

haps the more interesting verbs are the ones where the number of semantic arguments differs from that of syntactic arguments (6-7). Section 1.2 illustrates further examples of semantics/syntax mismatches.

1.2 Mismatches between semantics and syntax

So far, we've seen that sometimes the number of semantic and syntactic arguments are perfectly aligned, and sometimes they are not for a given verb. Next, we illustrate with a few oft-cited examples that these mismatches also occur across verbs denoting the same event.³

Consider verbs denoting ingestion of food, such as *eat*, *devour*, *dine*, *munch*, *binge*, *peck*, *gobble* and *chow*. Semantically, all these verbs denote an *eating* event and take two semantic arguments: someone eating and something being eaten. Syntactically, these semantic arguments would typically correspond to the subject (the eater) and the object (what is being eaten). However, these verbs differ on how the object is expressed in the linguistic string.

The comparison of *eat* and *devour* is a classic example (Jackendoff, 2002, p. 133-134). Both verbs take two semantic arguments: someone ingesting and the food being ingested. These are denoted by 'Octavian Jr.' and 'the cheesy bread' in (8-a) and (9-a), respectively. There is however a key difference between (8-a) and (9-a). In (8-a), 'the cheesy bread' is obligatory in the linguistic string: omitting it renders the sentence ungrammatical (8-b). In (9-a), 'the cheesy bread' is optional in the linguistic string, as indicated by the parentheses. Omitting it does not render the sentence ungrammatical (9-b). We refer to such arguments as *optional* syntactic

³This section is adapted and revised from Barbu and Toivonen (2016b).

arguments: they don't have to be present in the linguistic string.

- (8) a. Octavian Jr. devoured the cheesy bread.
b. *Octavian Jr. devoured.
- (9) a. Octavian Jr. ate (the cheesy bread).
b. Octavian Jr. ate.

The verb *dine* does not require an object (10-a). In fact, it cannot take an unmodified object (10-b), and there are mixed intuitions as to whether it can take an object preceded by the preposition *on* (10-c), as indicated by the question mark:

- (10) a. Sam and Sarah dined.
b. *Sam and Sarah dined hamburgers.
c. ?Sam and Sarah dined on hamburgers.

The verb *munch* can take a prepositional object, and the preposition *on* is optional at least for some speakers.

- (11) a. Sam munched on potatoes.
b. ?Sam munched potatoes.

An informal survey of native English speakers suggests that examples like (11-a) (with *on*) are preferred over examples like (11-b) (without *on*). When asked whether *munched potatoes* is grammatical, most speakers responded it is not. However, Google searches returned examples without the preposition, including some from book sections:

- Thousands of spectators munched potatoes and hot dogs as they cheered the

banners with their anti-Catholic slogans. (Almon, 1996, p. 19)

- As I munched potatoes, I watched her. (Burns, 2012)

The verbs *binge* and *peck* can take an object, however, the object must be preceded by the prepositions *on* and *at*, respectively:

- (12) a. Sam binged on chocolate.
b. *Sam binged chocolate.

- (13) a. Katie pecked at her food.
b. *Katie pecked her food.

The verb *chow* can take an object, however, the object must be preceded by the preposition *on*, and the verb may be accompanied by the particle *down*:

- (14) a. Buffy chowed (down) on bones.
b. *Buffy chowed bones.

The verb *gobble* can take an object, however, the verb must be accompanied by the particle *up*:

- (15) a. Janine gobbled up her food.
b. *Janine gobbled her food.

Together, the examples above highlight verbs pertaining to the same class: verbs denoting ingestion of food. Semantically, these verbs involve the same two participants, someone eating and something being eaten. Syntactically however, their behaviour is heterogeneous. Specifically, the argument corresponding to what is being eaten is sometimes obligatory and sometimes optional in the linguistic string (8-9). Other

times it cannot be expressed in the linguistic string (10). Moreover, when expressed, the argument differs in whether it can or it must be preceded by a preposition, and in what that preposition might be (11-14). Additionally, some verbs may be accompanied by a specific particle (14), whereas others must be accompanied by one (15).

There are also pairs of verbs that describe the same event from different perspectives: *flee* and *chase*, *buy* and *sell*, *borrow* and *lend*, *receive* and *give*, etc. These paired verbs describe a single general event: a chasing event, a buying event, a borrowing event, or a giving event, respectively (see Gleitman, 1990). However, in these examples, verbs describing the same event differ in their argument structure. Compare *give* and *receive*:

- (16)
- a. Aura gave a new pair of pyjamas to Mary.
 - b. Aura gave Mary a new pair of pyjamas.
 - c. Mary received a new pair of pyjamas (from Aura).

Semantically, giving and receiving involve the exact same core participants: a giver, a receiver, and an object. Syntactically, however, the two differ in which participants are obligatorily expressed and how the participants map onto grammatical functions. *Giving* requires both the giver and the receiver to be expressed, where the receiver can be expressed either as a prepositional phrase (16-a) or as a noun phrase (16-b). On the other hand, *receiving* requires the receiver to be expressed while the giver is optionally expressed as a prepositional phrase (16-c). In the latter, the receiver is the subject, and not an object as in (16a-b).

We conclude, as we did with the ingestion verbs, that knowing what type of event the verb refers to is not enough to predict whether or how those participants are real-

ized syntactically. Both in the case of ingestion of food verbs and verbs denoting the same event but taking different perspectives, we saw examples of semantic arguments that are syntactically obligatory, syntactically optional, or have specific requirements (e.g., must be preceded by a particular preposition).

So far we've seen that not all semantic arguments are mapped syntactically. There are also examples of syntactic arguments that do not have a corresponding semantic argument. For example, 'it' in (17) is syntactically obligatory in English. Semantically however, 'it' does not correspond to an actual participant causing the rain.

(17) It rains.

A central question of this thesis is whether the unclear status of instruments that was mentioned earlier can be explained by this semantics/syntax distinction. Consider *cut* in (18):

- (18) a. Thai cut the bread with a knife.
b. Thai cut the bread.

In (18), 'with a knife' is semantically required for cutting to occur and is closely related to the meaning of the verb. Syntactically, however, it is not obligatory in the linguistic string. Consider the definitions of argumenthood discussed so far. On one hand, we said that arguments are closely related to the meaning of the verb, which 'a knife' clearly is. Thus, one may infer that 'with a knife' is an argument. We also said that arguments are frequently obligatory in the linguistic string, whereas adjuncts are (almost) always optional (Tallerman, 2014). Since 'with a knife' is syntactically optional, one may conclude it is an adjunct. Note however, this is an isolated example aiming to illustrate that the semantics/syntax distinction may be a contributing factor

in explaining the unclear status of instruments. As we will explore in Chapter 3, instrument phrases do not form a unified class.

It is worth noting that instruments are not the same as unexpressed objects such as ‘the cheesy bread’ in (9), repeated here.

- (19) a. Octavian Jr. ate (the cheesy bread).
 b. Octavian Jr. ate.

Optional syntactic arguments such as the direct object of *eat* in (19) pattern with arguments based on a variety of syntactic argumenthood tests whereas instruments don’t. We discuss these syntactic diagnostic tests in Chapter 3.

The fact that there is no universally agreed upon way to distinguish between arguments and adjuncts, and the fact that there are mismatches between semantics and syntax speak to the complexity of the argument/adjunct distinction rather than question its existence. As we will see in Chapter 2, this distinction is widely established with cross-linguistic, psycho- and neuro-linguistic, and clinical evidence.

1.3 A note about terminology

To be consistent with my use of terminology, I will lay out recurring terms and their definitions. Consider example (20):

- (20) Sarah cut the cake with a knife at her wedding at the reception hall.

The term *participant* is used throughout this thesis in a general sense. It does not necessarily refer to a person. A participant can be a person or a thing, or perhaps a place or a time. In (20), the participants involved in the cutting event are ‘Sarah’, a

person; ‘the cake’, an object; ‘with a knife’, an object; ‘at the wedding’, a time; and ‘at the reception hall’, a place.

Participants are further classified as *core*, *peripheral*, and *salient* participants.⁴ Core and peripheral participants correspond to clear arguments and adjuncts, respectively. In (20), the core participants are ‘Sarah’ and ‘the cake’; the peripheral participants are ‘at her wedding’ and ‘at the reception hall’. We introduce the term *salient* to refer to instrument phrases such as ‘with a knife’ in (20) whose status is unclear.

The term *semantic* arguments is used when discussing the conceptual nature of the event. At the syntactic level, we use the term *syntactic* arguments to refer to all the arguments licensed by the verb. Some of these syntactic arguments are *obligatory* in the linguistic string, such as the direct object of devour; others are *optional*, such as the direct object of eat.

1.4 Structure of the thesis

The thesis is structured as follows: Chapter 2 reviews evidence for the argument/adjunct distinction from theoretical linguistics, psycho- and neuro-linguistic studies, and from clinical studies. Chapter 3 reviews the literature on the status of instruments. Chapter 4 presents two experiments which assess speakers’ semantic and syntactic intuitions about instruments in English, Spanish, Turkish, and Romanian. Chapters 5 and 6 report how two atypical populations compare to healthy controls on argument structure measures and discuss a method of analysis that accounts for within-group

⁴The term ‘salient’ was coined retroactively based on the findings of the studies presented in Chapter 4.

variation. Finally, Chapter 7 concludes with final remarks.

Chapter 2

Background

2.1 The argument/adjunct distinction cross-theories

The argument/adjunct distinction is adopted by most linguistic theories. This section provides a high level overview of the argument/adjunct distinction across select grammatical frameworks with the intention of emphasizing that, despite other differences, the connection between the verb and its arguments is crucial to most, perhaps all, approaches to syntax and semantics.

We begin our discussion in the 5th or 6th century B.C. with Dakshiputra Pāṇini, ‘the greatest linguist of antiquity, if not of all time’ (Staal and Staal, 1972). Pāṇini introduced the karaka theory which mentions six participants (karakas) necessary to describe the action expressed by the verb: ‘one who is independent; the agent’, ‘what the agent seems to attain; deed, object’, ‘the recipient of the object’, ‘that which is fixed when departure takes place’, ‘the main cause of the effect; instrument’, and ‘the basis, location’ (Kak, 1987). The first three remind us of the agent, theme, and recipient/goal. Instrument and location are particularly interesting, as they are often

controversial with respect to their status as arguments or adjuncts.

A more recent reference is Lucien Tesnière's Dependency Grammar (DG) and Valency Theory. Tesnière draws a parallel between sentences and dramas such that a sentence consists of actants (actors) and circonstants (circumstances). The actants represent core participants 'les actants sont les personnes ou choses qui participent à un degré quelconque au procès' and the circonstants represent peripheral participants 'les circonstants expriment les circonstances dans lesquelles se déroule le procès' (Tesnière, 1959). In other words, the actants are arguments, and the circonstants are adjuncts.

Role and Reference Grammar (RRG; Van Valin Jr and LaPolla, 1997) divides the sentence into three parts: the nucleus, the core, and the periphery. The nucleus contains the predicate (the verb), and the core consists of the nucleus and its arguments. The periphery contains the non-arguments (adjuncts). In example (21) below, 'Bill' and 'the soda' are core arguments whereas 'in the park' is an adjunct.

- (21) a. Bill drank the soda in the park.

Within the core, RRG further distinguishes between *direct* core arguments and *oblique* core arguments. In example (22), 'Bill' and 'the book' are direct core arguments whereas 'to Fred' is an oblique core argument.

- (22) a. Bill gave the book *to Fred*.

The difference between direct and oblique core arguments in English is that direct core arguments are unmarked, whereas oblique core arguments are adpositionally marked. Though oblique arguments may be mistaken as a peripheral PP, there are two distinguishing features. Semantically, oblique core arguments are represented in

the semantic representation of the verb along with direct core arguments; adjuncts are not. Syntactically, oblique core arguments can also occur without a preposition (23-a), whereas adjuncts cannot (23-b).

- (23) a. Bill gave Fred the book.
b. *Bill drank the park the soda.

RRG posits an additional category referred to as argument-adjuncts such as ‘to the store’ in (24).

- (24) Bill ran *to the store*.

In example (24), ‘the store’ is introduced by the preposition *to*, not by the meaning of the verb *run*. However, ‘the store’ shares an argument (Bill) with the logical structure of the verb such that Bill is running and Bill is at the store. This - sharing an argument with the logical structure of the verb - is the defining feature of argument-adjuncts.

The lexicon is central in RRG, but lexical information contains mainly semantic information. Based on the lexical information, verbs are categorized into different semantic classes, and information about semantic roles follow from this classification. Syntactic subcategorization is not directly encoded in the lexical entries, but is derived by general principles from the semantics. In sum, the argument/adjunct distinction is crucial in RRG, since the sentence is organized to separate arguments from adjuncts by distinguishing the core from the periphery, and information about argument structure is indirectly deduced from lexical information.

The conceptualization of grammar embraced by the Minimalist Program (MP; Hornstein et al., 2005) and its predecessor, Government and Binding Theory (GB; Chomsky, 1981) is quite different from that developed in DG and RRG, however, the

relationship between the verbal head and its arguments remains central across all of these frameworks. Consider example (25). Both GB and MP allow sentences such as (25-a) while prohibiting sentences such as (25-b), though they accomplish this in different ways:

- (25) a. I ate the cookie.
 b. *I ate the cookie the apple.

In GB, this is accomplished by the Theta-Criterion and the Projection Principle, the two central principles that constrain the distribution of arguments (Chomsky, 1981). Together, these principles ensure that information about the verb's arguments is represented at every level of syntactic representation. The verb lexically specifies the number of theta-roles (thematic roles) it assigns. The theta roles must then be assigned to every syntactic argument, and only to syntactic arguments (the Theta Criterion). This information must be present at every stage of the derivation (the Projection Principle). These core grammatical principles do not cover the presence and distribution of adjuncts.

In MP, examples such as (25-b) are ruled out by Full Interpretation, which states that all the elements (ate, the cookie, the apple) must be legible at the Phonetic Form and the Logical Form interfaces. If the elements are illegitimate, the derivation crashes at the relevant interface.

The difference between arguments and adjuncts is also evident in the phrase structural representation, which is central to both GB and MP. Arguments can occupy a verb's specifier and complement positions, while adjuncts typically cannot. In terms of the latter, there are different analyses proposed for how adjuncts should be represented phrase-structurally. Popular in GB is "Chomsky-adjunction", wherein the

sister phrase of an adjunct is the same as its mother phrase.

In MP, some still represent adjunction with Chomsky-adjunction as in GB. Others such as Cinque (1999), recently reviewed in Cinque (2004), argue that adjuncts are Merged in the specifier of functional heads. Chomsky (2014, Chapter 4) suggests that adjunct phrases are labelled differently than argument phrases, while Hornstein and Nunes (2008) propose that adjuncts are structurally simpler than arguments: adjuncts modify events directly, whereas arguments do so indirectly, aided by relational notions. The authors thus propose that arguments must be part of complex, labelled structures, whereas adjuncts need not be integrated into labeled structures. In other words, contrary to Chomsky (2014, Chapter 4), Hornstein and Nunes (2008) argue that the difference between arguments and adjuncts is not a different label, but the absence of one.

Crucially, despite operational or structural differences between (or within) GB and MP, the argument/adjunct distinction is in general maintained across both frameworks.

In Lexical-Functional Grammar (LFG; Kaplan et al., 1982; Dalrymple, 2001, Bresnan et al., 2016), different kinds of linguistic information are modelled by distinct, parallel grammatical modules. Each module is formalized with its own type of representation (e.g., syntactic trees, feature structures). The connection between a verb and its arguments and the argument/adjunct distinction are crucial in each of the three syntactic modules: c(onstituent)structure, f(unctional)-structure, and a(rgument)-structure. At c-structure, arguments appear in complement or specifier position and adjuncts appear in adjunct positions, if a configurational language is being modelled. A-structure models the basic specifications of the argument structure of verbs: each

head is associated with a list of arguments ordered according to the thematic hierarchy. F-structure models grammatical functions (e.g., SUBJECT, OBJECT) as feature structures. There are specific adjunct functions (ADJUNCT, XADJUNCT), the other functions are different argument functions. Two principles, Completeness and Coherence, ensure that exactly the arguments specified by the predicate are present in the f-structure headed by that predicate.

In Head-Driven Phrase Structure Grammar (HPSG; Pollard and Sag, 1994), arguments are introduced as an ordered list, lexically associated with heads. The list is the value of a feature called “SUBCAT” (for subcategorization). The arguments are ordered on this list according to the obliqueness hierarchy (Pollard and Sag, 1994, p. 24). In contrast, adjuncts select their heads through a specific function called MOD(ifier) (Pollard and Sag, 1994, p. 55). Later work (Sag et al., 2003) split the SUBCAT feature into two features: VALENCE, where the arguments are separate so that the external argument occupies its own list, and “ARG-ST” (for argument structure), which allows reference to all arguments on the same list. In Sag et al. (2003), modifiers are introduced with a special head-modifier rule, which adds members to a separate list (“MOD”) alongside the argument lists as part of the VALENCE feature.

Construction Grammar (CG; Goldberg, 1995; Kay and Fillmore, 1999; Kay, 2005) differs from the approaches listed above in that arguments are not necessarily introduced by lexical heads. Arguments can also be introduced by constructions. The verb and the arguments introduced by the verb must match the semantic characteristics of the construction and its arguments (Goldberg, 1995, 2006). The arguments introduced by constructions can be compared to arguments introduced by derivational morphology (such as applicatives) and lexical rules in many other frameworks.

Adjuncts are introduced by their own constructions (Kay, 2005; Goldberg, 2006).

Kay (2005) distinguishes between *inherent* or *profiled* arguments (Boas, 2013), *added* arguments, and adjuncts. Verbs are associated with participant roles based on meaning of the verb. Some of these participant roles are *profiled*, and they correspond to a profiled argument. For examples, *sneeze* is associated with one participant role, the ‘sneezer’, which corresponds to a profiled argument such as ‘Shiru’ in (26). The added arguments (‘the napkin’ and ‘off the table’ in (26-b)) and the adjunct (‘in the kitchen’ in (26-c)) are introduced through a *caused-motion* construction and an *adjunct-specific* construction, respectively.

- (26) a. Shiru sneezed.
 b. Shiru sneezed the napkin off the table.
 c. Shiru sneezed in the kitchen.

Though ‘off the table’ in (26-b) may seem analogous to ‘in the kitchen’ in (26-c), the two can be distinguished both semantically and syntactically.¹ Semantically, ‘in the kitchen’ characterizes the sneezing event, whereas ‘off the table’ denotes the path traversed by the napkin. The property of contributing to the sneezing event rather than characterizing it is what identifies ‘off the table’ as an argument and ‘in the kitchen’ an adjunct. Syntactically, adjuncts are easily fronted (27-a) whereas added arguments are often more resistant (27-b).

- (27) a. In the closet, the top was spinning.
 b. *Off the table, the top was spinning.

¹Additionally, ‘in the kitchen’ is an adjunct by well-established diagnostic tests, which we review in Chapter 3.

The constructional approach to argumenthood is a bit different from the approach of other theories, but the distinction between arguments and adjuncts is nevertheless important in CG.

2.1.1 Interim summary

This concludes our discussion of theoretical approaches to the argument/adjunct distinction. The overview here is superficial and more can be said (and has been said) about argumenthood in the frameworks listed here, as well as in frameworks that we have not mentioned. While this review barely scratches the surface, it is intended to highlight that argument structure is a fundamental concept in most linguistic theories. This review is adapted from Barbu and Toivonen (2016a), Section 2.

2.2 Psycholinguistic and neurolinguistic evidence

So far we have reviewed evidence for the argument/adjunct distinction from theoretical linguistics and offline judgements. Psycho- and neurolinguistic studies provide further evidence for the psychological reality of the distinction. Eye-tracking monitors the participants' gaze during various activities revealing insights about the underlying cognitive processes. Electroencephalography (EEG) measures brain activity at the scalp providing insight into the neural mechanisms associated with processing. Imaging studies, functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG), are typically used for the localization of cognitive function, however, they can also inform cognitive theories (Shetreet et al., 2010).

In this section, we rely on such studies to provide additional support for our claim

that the argument/adjunct distinction is real.

2.2.1 The argument/adjunct distinction

You may recall we have talked about the argument/adjunct distinction and how sometimes the semantics/syntax correspondence is not always perfect. The studies reviewed in this section rely on examples where the distinction is clear at both levels. Boland (2005) and Boland and Blodgett (2006) used eye-tracking to monitor participants' gaze and investigated whether any differences emerge between arguments and adjuncts. In Boland (2005), participants listened to one-argument verbs and three-argument verbs while seeing related pictures. Example (28) illustrates a one-argument verb, *sleep*, followed by a typical location such as a 'bed' (28-a), or an atypical location such as a 'bus' (28-b). In both scenarios, the locations are adjuncts.

- (28) a. The girl slept for a while on the bed this afternoon.
picture: girl, bed, pillow, toy, car
- b. The girl slept for a while on the bus this afternoon.
picture: girl, bus, pillow, toy, car

Example (29) illustrates a three-argument verb, *suggest*, followed by either a typical recipient such as 'teenager' (29-a), or an atypical recipient such as 'toddler' (29-b). In both scenarios, the recipients are arguments.

- (29) a. The newspaper was difficult to read but the mother suggested it anyway
to her teenager last week.
picture: newspaper, mother, teenager, dictionary
- b. The newspaper was difficult to read but the mother suggested it anyway

to her toddler last week.

picture: newspaper, mother, toddler, dictionary

In a first experiment, typical locations were looked at over atypical ones, whereas the difference between typical and atypical recipients was negligible. In other words, the typicality effect seemed to affect adjuncts but not arguments. Additionally, recipients were looked at more than adjuncts, regardless of typicality. This suggests a preferential status of arguments over adjuncts. Together, the findings suggest that the participants' gaze was influenced both by the verb's arguments and by real world knowledge.

In a second experiment, participants saw the typical and atypical options (bed vs. bus; teenager vs. toddler) simultaneously. In this scenario, the main effect of typicality extended to recipients such that both typical arguments and adjuncts were looked at more than their atypical counterparts. The authors interpreted the results such that the verb's argument requirements were used to identify potential recipient arguments. If several potential recipients were present, real world knowledge was used to select the most likely candidate. Since both argument status and typicality effects were at play, the authors conducted a third experiment to tease apart arguments and adjuncts while keeping typicality constant. The stimuli consisted of sentence pairs such as in (30):

(30) One window was broken so the handyman ...

- a. mentioned it right away to the owners.
- b. fixed it hurriedly for the owners.

picture: broken window, handyman, owners, tools

Example (30) keeps typicality constant by using the same noun phrase ‘the owners’ in both examples while varying its status. Specifically, ‘the owners’ is an argument in (30-a) and an adjunct in (30-b). In this scenario, the ‘owners’ NP received more looks when it denoted an argument than when it denoted an adjunct. Taken together, these studies illustrate the preferential status of arguments over adjuncts, but also of argument structure over world knowledge in guiding participants’ gaze.

Boland and Blodgett (2006) set out to test the same hypothesis: that arguments are processed differently than adjuncts. This time around, participants read a series of sentences such as (31a-b) below:

- (31) The famous author mailed his revisions ...
- a. to the editor (VP argument)
 - b. for a fee (VP adjunct)

Findings showed that readers spent less time on arguments (31-a) than on adjuncts (31-b) providing further support for the argument/adjunct distinction. The authors interpreted the shorter time spent on arguments than on adjuncts as support for the claim that verbs facilitate the processing on their arguments (Boland and Blodgett, 2006). Since arguments are licensed by the verb, they are easier to process than adjuncts. This in turn led to faster reading times for the arguments.

In a more recent study, Di Giovanni (2016) made use of both behavioural and EEG techniques to contrast arguments and adjuncts in plausible sentences (32a-b) and in less plausible/implausible sentences (32c-d):

- (32) a. Today in the morning John washed quickly.
b. Today in the morning John washed Michael.

- c. Today in the morning John washed tightly.
- d. Today in the morning John washed pencils.

At the behavioural level, arguments had a shorter reaction time than adjuncts in both conditions. Additionally, adjuncts overall had a larger standard deviation than arguments. This was consistent with the author’s hypothesis that “verbs cue their arguments” but not adjuncts. The fact that the adjuncts are not predicted by the verb may lead to individual differences in interpreting adjunct information.

The EEG data also showed differentiation between less plausible arguments and less plausible adjuncts with the two eliciting different event-related potential (ERP) patterns. More specifically, less plausible arguments elicited a brain response called N400 relative to less plausible adjuncts. N400 is a language-related brain response associated with semantic violations, first reported by Kutas and Hillyard (1980), elicited by sentences such as (33-b) relative to (33-a):

- (33) a. I take my coffee with cream and sugar.
b. *I take my coffee with cream and dog.

Additional differences were captured with an event-related spectral perturbation analysis which revealed increased alpha power associated with adjuncts relative to arguments. Taken together, these findings provide ample evidence for the hypothesis that arguments and adjuncts are processed differently in the brain.

2.2.2 Number of arguments

While the studies above clearly show a difference between arguments and adjuncts, others take this distinction for granted and explore various subtleties of argument

structure. As we saw in Section (1.1), verbs differ in the number of arguments they involve. For example, *sleep* is a one-argument verb (Mary sleeps), *see* is a two-argument verb (Mary sees Anna), and *give* is a three-argument verb (Mary gives Anna a present).

In a pioneering fMRI study, Thompson et al. (2007) presented participants with 120 verbs, equally divided across one-, two-, and three-argument verbs. Findings showed that two-argument verbs elicited greater activation than one-argument verbs, and two- and three-argument verbs combined elicited greater activation than one-argument verbs.

Other studies also reported increased neuronal activation in verbs with a higher number of arguments when the verbs were presented in isolation (Thompson et al., 2010; Meltzer-Asscher et al., 2015); in a sentence context (Shetreet et al., 2006; Ben-Shachar et al., 2003); and in a production task (den Ouden et al., 2009).

So far, we talked about verbs which differ in the number of arguments they take. Other verbs such as *to break* may be used in one-argument constructions (34-a) and in two-argument constructions (34-b). These verbs are referred to as alternating verbs.

- (34) a. The window broke.
 b. Marian broke the window.

In contrast, verbs such as *to laugh* are exclusively used in one-argument constructions (35-a). If used in two-argument constructions (35-b), such verbs render ungrammatical sentences:

- (35) a. The child laughed.

- b. *The clown laughed the child.²

When contrasting alternating and non-alternating verbs presented in isolation, Meltzer-Asscher et al. (2013) reported significantly greater activation for alternating compared to non-alternating verbs. These findings suggest that both one-argument and two-argument constructions may be activated when hearing an alternating verb. This in turn may lead to increased cognitive processing which explains the increased neuronal activation. Differences between alternating and non-alternating verbs were also captured by Malyutina and den Ouden (2017).

In sum, these studies show that verbs with a higher number of arguments are associated with increased neural activation.³ The methods and findings reported in this section pave the path to further explore the argument/adjunct distinction. Consider the verbs *kiss*, *give*, and *paint*. The verb ‘kiss’ takes two arguments: someone kissing and someone being kissed. The verb ‘give’ takes three arguments: someone giving, something to be given, and someone receiving. Based on the results reported above, we predict that ‘give’ would elicit increased neuronal activation compared to ‘kiss’. On the other hand, the number of arguments of the verb ‘paint’ is unclear depending on whether the brush is an argument or an adjunct (someone painting, something to be painted, and perhaps something to paint with). If ‘paint’ elicits similar activation as ‘kiss’, one may conclude that the instrument is an adjunct. Alternatively, if it patterns with ‘give’, one may conclude that the instrument is an argument. A third

²Examples (34, 35) are adapted from Schäfer (2009). Example (35-b) had the intended meaning of *The clown made or caused the child to laugh*.

³In contrast, Hernández et al. (2014) found lower neural activity for two-argument verbs than for one-argument verbs. Though the authors attributed the unexpected result to the fact that two-argument verbs have a higher prototypicality than one-argument verbs, making them easier to process, this does not explain why other studies found higher activation for two-argument verbs than for one-argument verbs.

possibility is that the verb ‘paint’ patterns with neither ‘kiss’ or ‘give’, suggesting that the status of the instrument is different than that of a clear argument or adjunct. Such experiments may provide insights into the status of controversial phrases such as instruments.

2.2.3 The semantic/syntactic nature of argumenthood

Rösler et al. (1993) were among the first to explore brain activity patterns associated with argument structure. Their stimuli consisted of sentences such as (36) below:

- (36) a. The parcel is being delivered.
 b. *The honey is being murdered.⁴

Example (36-b) is odd because *honey* is an unlikely passive subject of *be murdered*. The violation elicited an N400 response, indicative of the semantic violation.

N400 is often discussed in relation to P600, a peak elicited by syntactic violations (Coulson et al., 1998) such as (37-b) relative to (37-a):

- (37) a. Every Monday he mows the lawn.
 b. *Every Monday he mow the lawn.

While Rösler et al. (1993) and Coulson et al. (1998) report semantic and syntactic violations in isolation, respectively, some studies report brain activity associated with both types of violations. The corresponding ERP response is known as N400-P600.

Friederici and Frisch (2000) compared violations related to the *number* of arguments and the *type* of arguments in German. The *number* of arguments violation

⁴Typically (*) is used to denote ungrammatical sentences. Example (36-b) however, is not ungrammatical, it is just semantically infelicitous. We marked it with an (*) as per Rösler et al. (1993).

was created by presenting two NPs with a one-argument verb (38-b). The *type* of arguments violation was achieved with a wrong case marking: accusative instead of dative in (38-c).

- (38) a. Anna weiß, dass der Kommissar (NOM) den Banker (ACC) abhörte (V)
und wegging.
Anna knows that the inspector (NOM) the banker (ACC) monitored (V)
and left.
- b. *Anna weiß, dass der Kommissar (NOM) den Banker (ACC) abreiste (V)
und wegging.
Anna knows that the inspector (NOM) the banker (ACC) departed (V)
and left.
- c. *Anna weiß, dass der Kommissar (NOM) den Banker (ACC) beistand (V)
und wegging.
Anna knows that the inspector (NOM) the banker (ACC) helped (V)
and left.

The two types of violations elicited different ERP responses. Specifically, having two arguments instead of one led to a N400-P600 response whereas having an inappropriate argument, i.e., wrong case marking, led to a biphasic left lateralized negativity followed by a P600. Frisch and Schleewsky (2001) also reported an N400-P600 elicited by sentences with two phrases case-marked as subjects (39-b) relative to a control (39-a).

- (39) a. Paul fragt sich, welchen Angler der Jäger gelobt hat
Paul asks himself [which angler] ACC [the hunter] NOM praised has

- b. Paul fragt sich, welcher Angler der Jäger gelobt hat.

Paul asks himself [which angler] NOM [the hunter] NOM praised has

Friederici and Frisch (2000) and Frisch and Schleewsky (2001)'s findings were later replicated by Friederici and Meyer (2004) and Frisch et al. (2004) who also reported an anterior negativity followed by a P600 elicited by a missing argument.

In sum, these studies further highlight the relationship between a verb and its arguments. The various experimental conditions also illustrate that semantic and syntactic violations are processed differently; however, this should be taken with a grain of salt because recent literature suggests N400 and P600 are a lot more complex than previously thought (Brouwer et al., 2017; for a review, see Brouwer et al., 2012).

2.2.4 Argument structure subtleties

In a straightforward fMRI study, Lee et al. (2014) compared within class priming (e.g., noun - noun such as spider - scorpion) with cross-class priming (e.g., verb - noun such as camouflage - salamander) in an English lexical decision task. Their hypothesis was that argument structure processing is automatically triggered when a verb and a potential argument are present. Two main findings supported their hypothesis. Firstly, cross-class priming elicited enhanced activation compared to within-class priming. This enhanced activation was observed in brain regions previously associated with argument structure processing, specifically in the posterior superior temporal gyrus. Secondly, within the cross-class priming condition, there was a word order effect such that predicting a noun following a verb was easier than predicting a verb following a noun. This finding suggests that seeing the verb activates its argument structure, which in turn leads to the anticipation of arguments.

In a similar design, Maess et al. (2016) presented participants with verbs and nouns in an MEG experiment. In this case, the experimental manipulation was the predictive power of the verb in relation to the noun. For example, given the noun *car*, a verb such as *drive* was said to have a high predictive power. A verb such as *get* was said to have a low predictive power. Results showed that verbs with a high predictive power elicited a high N400 whereas the following noun elicited a low N400. Conversely, verbs with low predictive power had a low N400, whereas the following noun had a N400. The authors explained these perhaps unexpected findings on the basis that verbs with high predictive power had a high N400 caused by the anticipation or pre-activation of the upcoming noun. Most relevant for us, the findings emphasize the verb - noun relationship and highlight that the predictive power of the verb is directly related to the processing of the subsequent noun, or the verb's argument.

While Lee et al. (2014) and Maess et al. (2016) provide support for the claim that the relationship between verbs and their arguments is special, other studies explore the various facets of argument structure. Shetreet et al. (2006) and Malyutina and den Ouden (2017) found that verbs with more possible types of arguments led to increased activation. For example, some transitive verbs only attach noun phrases as their second argument (40a-b) whereas other verbs may be complemented by either a noun phrase (40-c) or a clause (40-d):

- (40)
- a. He completed the work.
 - b. He completed that task.
 - c. He added salt.
 - d. He added that despite having little experience, he is an incredibly fast learner.

Shetreet et al. (2010) compared verbs that take one type of argument such as in (40a-b), with verbs that take two types of arguments such as in (40c-d) with verbs with optional arguments such as *eat*. Interestingly, verbs with optional arguments patterned with verbs which take one type of arguments.

In a recent study, Sassenhagen et al. (2018) investigated how verb-argument structure preferences are acquired by means of a behavioural and an EEG experiment, respectively. The stimuli consisted of high and low frequency intransitive verbs used in their intransitive as well as (ungrammatical) transitive form. The examples in (41) illustrate the stimuli. The verb *laugh* is frequent and *giggle* is not.

- (41)
- a. On Wednesday, Bob laughed in the kitchen.
 - b. *On Wednesday, Bob laughed the girl in the kitchen.
 - c. On Wednesday, Bob giggled in the kitchen.
 - d. *On Wednesday, Bob giggled the girl in the kitchen.

In a behavioural acceptability task, speakers' rating accuracies were near perfect for all conditions except *low frequency* transitive violations (41-d). In the EEG recording, ungrammatical sentences (41-b, -d) elicited a P600 relative to grammatical ones (41-a, -c). Within the ungrammatical sentences, low frequency transitive sentences elicited a different ERP response compared to high frequency ones. The behavioural findings suggest that the acquisition of grammatical constructions may occur via statistical cues whereas the EEG findings highlight that the brain perceives having an extra anomalous argument as a syntactic violation. This reinforces the need to tease apart the semantic and syntactic factors when investigating the argument/adjunct distinction.

2.2.5 Interim summary

This concludes our discussion of psycho- and neuro-linguistic approaches to investigating argument structure. Though not fully comprehensive, the overview here is intended to highlight that the argument/adjunct distinction is real, the close relation between verbs and their arguments, and some of the subtleties surrounding different types of arguments.

2.3 Clinical evidence

This section reviews clinical evidence which provides support for the argument/adjunct distinction and further highlights the subtleties of argumenthood. Argument structure impairments are particularly studied in aphasia (Caley et al., 2017; Whitworth et al., 2015; DeDe, 2013; Barbieri et al., 2010; Kegl and Poizner, 1997, among others), whereas literature on argument structure in other conditions is scarce. As a secondary goal, this section aims to draw awareness to less discussed conditions where argument impairments may occur.

2.3.1 The argument/adjunct distinction

Lee and Thompson (2011) investigated real-time production of arguments and adjunct in healthy individuals and in agrammatic speakers. Participants were shown a picture with written stimuli as shown in Figure (2.1):

Participants saw a verb on the left side, and three nouns on the right side. The verb was manipulated across paired trials such that one of the noun phrases on the right side was an argument (a), or an adjunct (b). The participants' task was to form

Figure 2.1: Sample stimuli adapted from Lee and Thompson (2011)

a sentence while their gaze was monitored with an eye-tracker. Findings revealed that adjuncts elicited a greater gaze duration than arguments in both groups. The authors interpreted these findings as higher processing costs associated with adjunct production (42-a) than argument production (42-b).

- (42) a. The mother **is applying** lotion to the baby.
 b. The mother **is choosing** lotion for the baby.

Interestingly, while adjunct production was associated with higher processing costs in both groups, these costs were reported during sentence production in healthy speakers whereas in agrammatic speakers, the costs were reported during the sentence production stage, but also in the planning stage (as they were fixating on the words before starting to say the sentence).

2.3.2 Number of arguments

Grela (2003) investigated whether children with Down Syndrome (DS) have more difficulty with argument structure than typically developing children. The nature of the research question itself, whether this population presents with argument structure

impairments, rather than characterizing the nature of these impairments speaks to the infancy of the research avenue. The language sample consisted of transcriptions of child-caregiver interaction during free play. As part of the study, the author assessed production of subjects, objects, and any inappropriate uses of arguments such as **The boy looks the donkey* instead of *The boy looks at the donkey*.

Findings showed similar omission rates across groups for both one- and two-argument verbs. Within two-argument verbs however, children with DS were more likely to omit subjects than objects. Based on this finding, the author concluded that children with DS do not have an argument structure impairment per se, but that they have a slower development. Specifically, they were still in the optional subject phase. In terms of anomalies, typically developing children produced more sentences with inappropriate uses of arguments.

Michael et al. (2012) also reported subject omission in children with Down Syndrome. The subject omission was more prominent in two- and three-argument verbs relative to one-argument verbs. Additionally, the children also had difficulty with verb production in a narration task. Similar to the subject omission, errors were more prevalent in verbs with an increased argument structure. In contrast to Grela (2003), Michael et al.'s (2012) study indicates a potential argument structure impairment, particularly in verbs with increased argument structure. Beeke et al. (2007) and Kim and Thompson (2000) report similar findings in individuals with agrammatism. Specifically, on an assessment of verb retrieval in the former, and a naming task in the latter, the patients' performance decreased as the verb's argument structure increased.

In sum, these studies provide support for the claim that verbs with a higher

number of arguments are associated with increased processing, also consistent with the neuro-imaging evidence discussed in the previous section.

2.3.3 The semantic/syntactic nature of argumenthood

Kohen et al. (2011) investigated the effects of the semantic and syntactic facets of argument structure on sentence repetition in agrammatism. Their stimuli consists of minimally different sentence pairs (43-44):

- (43) a. The driver **turned off** the lights.
b. The driver turned **off the road**.
- (44) a. The secretary **crossed out** the names.
b. The secretary crossed **over the bridge**.

In examples (43-a) and (44-a), the particles *off* and *out* form a unit with the verb. The authors assumed that *turn off* and *cross out* are single lexical items because they can be replaced by *extinguish* or *strike*, respectively. They refer to these examples as *verb-particle constructions*. In examples (43-b, 44-b), the prepositions *out* and *over* accompany the following NPs. The authors refer to such examples as *prepositional transitive constructions*.

The authors intended for this contrast to probe into the contribution of the semantic and the syntactic facets of argument structure. They argued that prepositional transitive constructions have a more complex argument structure than verb-particle constructions both semantically and syntactically.

From a semantic perspective, example (43-a, 44-a) consist of three units: the driver, turn off, the lights; and the secretary, cross out, the names, respectively. Ex-

amples (43-b, 44-b) consist of four units: the driver, turn, off, the road; and the secretary, cross, over, the bridge, respectively. The preposition provides an independent contribution of semantic information (e.g., about direction or location). Syntactically, prepositional transitive constructions are more complex due to the embedding of a prepositional phrase within the verb phrase.

The findings showed that verb particle phrases (43-a, 44-a) were repeated correctly more often than prepositional transitive ones (43-b, 44-b). This provides support for the authors' claim that prepositional transitive sentences are more complex than verb particle ones. Another key distinction between the two constructions is that the prepositional phrases indicate locations (*off the road*, *over the bridge*). As discussed earlier, locations are typical adjuncts, thus their status here may be controversial between arguments and adjuncts. In fact, the authors determined post-hoc that seven out of thirty prepositional phrases were adjuncts rather than arguments. This then raises the question of whether the differences between conditions is due to differences in semantic and syntactic complexity, or due to the argument/adjunct distinction.

Kim and Thompson (2004) investigated verb-related difficulties, or *verb deficits* in the authors' terminology, in probable Alzheimer's Disease (PrAD) and in agrammatic aphasics. The authors teased apart the semantic and syntactic facets of argumenthood. They defined the syntactic nature of verbs as "the number of arguments associated with a verb", with no reference to the type or optionality of the arguments. Semantic complexity was defined as the increased complexity associated with verbs that are comprised of a number of primitive elements. For example, *run* is semantically more complex than *go* because aside from the traveling of a thing/person from a place to another, it also specifies manner (running). In other words, semantic

complexity was defined as the difference between light and heavy verbs.

Interestingly, though both groups showed verb-related impairments, the two were affected by different aspects of argumenthood. The agrammatic aphasics had difficulty with verbs with a higher number of arguments; thus, the syntactic facet of argumenthood. Individuals with PrAD had difficulties with heavy verbs; the semantic⁵ facet of argumenthood. Together, the results revealed a dissociation between semantics and syntax, by showing one can be impaired without the other, and vice versa.

2.3.4 Interim summary

This concludes our discussion of clinical evidence for argument structure. These select papers are intended to highlight that the dual nature of argument structure, along with its increased complexity as a function of the number of arguments is evident in processing in both typical and atypical populations, and a better understanding of it can have practical applications in the clinical space.

⁵Based on the authors' definition of that the semantic facet of argumenthood refers to.

Chapter 3

On instruments

3.1 Background

Instrument phrases such as ‘with a monkey wrench’ in (45) are difficult to classify as arguments or adjuncts (Goldberg, 2002; Webb, 2008; Tutunjian and Boland, 2008; Needham and Toivonen, 2011; Rissman, 2013; Barbu, 2015; Barbu and Toivonen, 2016b; Barbu and Toivonen, 2016a; Boland, 2017, p. 28):

(45) Dan changed the tire with a monkey wrench.

Section 3.1.1 reviews the definition of instruments. Section 3.1.2 addresses the argumenthood status of instruments, and Section 3.1.3 addresses how instrument verbs may not form a unified class. Specifically, the chapter discusses how some verbs require an instrument whereas others merely allow it; this is referred to as the *allow/require* distinction. A part of this thesis investigated whether this allow/require distinction may in part contribute to the unclear status of instruments as arguments or adjuncts.

3.1.1 Defining instruments

Instrument phrases refer to the “means by which an action is performed or by which something comes about” (Denham and Lobeck, 2012, p. 338); they are “intermediary between Actor and Patient in the decomposition of an action” (Jackendoff, 1987), and “intermediate in a causal chain between the subject (initiator) and the direct object (final affected entity)” (Croft, 1991, p. 178).¹ However, “these notions are seldom explicated or formalized” (Rissman, 2013).

In English, instruments are often embedded in a *with-prepositional phrase* (with-PP) such as ‘with a knife’ in (46-a) and ‘with a broom’ in (46-b):

- (46) a. The woman cut the bread with a knife.
 b. The custodian swept the floor with a broom.

It is sometimes difficult to distinguish instrument phrases from other with-PPs. Consider (47a-b) below:

- (47) a. The woman shoveled the snow with a shovel.
 b. The woman shoveled the snow with love.

The phrase ‘with a shovel’ in (47-a) is an instrument denoting the tool used to move the snow. The phrase ‘with love’ in (47-b) expresses the manner. In Section 1.1, we discussed Koenig et al.’s (2003) semantic obligatoriness and specificity criteria for

¹The intermediate/intermediary role of instruments refers to their position in a causal chain. Consider (i):

- (i) Chunyun used a sword to carve the pumpkin.

The *carving* event in (i) begins with Chunyun (who is doing the carving) and ends with the pumpkin (what is being acted on, or carved). The sword is the participant in between Chunyun and the pumpkin. It serves as ‘the intermediate stage in the transmission of energy’ (Ungerer and Schmid, 2013, p. 180).

argumenthood. Specifically, a participant is an argument if its presence is obligatory to describe the action denoted by the verb and is specific to the verb. The manner in which the shoveling is done, i.e., ‘with love’, is neither obligatory nor specific to shoveling. Firstly, one may shovel without any kind of manner. Secondly, virtually anything can be done in a particular manner, in this case ‘with love’. In contrast, shovelling does require a specific tool to move the snow. Based on these criteria, one may conclude that ‘with a shovel’ is an argument, whereas ‘with love’ is an adjunct.

Lakoff (1968) proposed an early heuristic to distinguish between *with*-instrumentals and *with*-adverbials: a nominal phrase (NP) serves as an instrument if it can be used in a *with-NP* construction (48-a) and in a *used-NP* constructions (48-b), and the two convey the same meaning:

- (48) a. Thai chopped the parsley with a knife.
 b. Thai used a knife to chop the parsley.

Now consider (49a-b):

- (49) a. Maria hugged her long-lost friend, Ana, with tears.
 b. *Maria used tears to hug her long-lost friend.

Compared to (48), example (49) illustrates a case where the *used-NP* construction is unnatural sounding. In this case, ‘with tears’ is a manner adjunct rather than an instrument.

Though the examples above are compelling, the *with/use* test cannot be the deciding factor as to whether a phrase is an instrument or not (Nilsen, 1973). Consider (50) and (51):

- (50) a. Tavi killed the boar with a gun.
 b. Tavi used a gun to kill the boar.
- (51) a. Tavi killed the boar with the bullet.
 b. */?Tavi used a bullet to kill the boar.

While both the *use-NP* and *with-NP* constructions are possible in (50), in (51), the *use-NP* yields an ungrammatical sentence.² A gun entails a bullet, thus, one would expect the transition from (50) to (51) to be natural. Nilsen (1973) explains that (51-b) is ungrammatical because there is a hierarchy in instrumentality such that *use-NP* cannot co-occur with an instrument controlled by another instrument such as a bullet controlled by the gun. Note however that (52) is felicitous³:

- (52) Tavi used a full-metal-jacket bullet to kill the boar.

Comparing the *used-NP* and *with-NP* raises the question of what exactly it means for the two to convey the same meaning. For example, the sentences may have the same truth-conditional meaning but differ in pragmatic appropriateness. Also, the *used-NP* construction guarantees or at least suggests intention on the agent's part whereas the *with-NP* constructions could be either intentional or accidental. Consider (49) repeated here and (54):

- (53) a. Maria hugged her long-lost friend, Ana, with tears.
 b. *Maria used tears to hug her long-lost friend.

Based on the example in (53), we concluded that *with tears* is a manner adjunct in

²I'd argue that (51-b) is perhaps odd-sounding or unnatural, however, Nilsen (1973) states it is ungrammatical.

³Thank you to Dr. Raj Singh for pointing this out and for discussion on the topic.

(53-a). However, the *used-tears* construction can also be used felicitously, as illustrated in the following book entries (Hewamanne, 2011, p. 98):

- (54) a. Some workers used tears to obtain assurances from supervisors of their position and value to the line.
 b. Some workers ... used tears to renegotiate their position as valued and privileged workers.

The *with-NP* equivalent of (54) gives no indication whether the tears were intentional or accidental. Thus, as examples (53-54) illustrate, sometimes, when both *with-NP* and *used-NP* constructions are possible, it is unclear whether the two have the same meaning.

In all, the discussion above leads to several generalizations. Not all *with*-phrases are instruments and determining whether a *with*-phrase is an adverbial or an instrumental is not always easy. Given our aim to understand the argumenthood status of instruments as arguments or adjuncts, the absence of a clear heuristic to distinguish between the two types of *with*-PPs contributes to the difficulty.

Schlesinger (2006, p. 63-65) posits a wide variety of instruments and defines ten categories, with the caveat that this list is not comprehensive.

- (55) Tool: objects such as knives, sticks, or computers used to perform tasks with
 Jack cut the cake with a knife.
 (56) Means of transportation: *by*-phrases denoting a means of transport
 Katie prefers travelling to Toronto by train.
 (57) Proper part: instruments which are part of the agent's body

The boy scratched this sister with his long nails.

(58) Abstract: abstract entities instrumental in accomplishing an activity

a. You ought to persuade him with kind words.

b. The dad built the tree house with patience.

(59) Material: materials involved in performing an activity without being a tool

He brushes his teeth with toothpaste.

(60) Means of communication:

The lottery informed him that he won \$1,000,000 by email.

(61) Secondary tool: tools which assist in the activity but do not perform the activity themselves

Octavian Jr. ate the ice cream with a spoon.

(62) Ingredient: substances which enable the creation of an object

The little boy built a gorgeous tower with Lego's.

(63) Ancillary instrument: instruments involved in an activity which enable the activity to be performed, but they do not act directly on the object

I grabbed the old family chest from the attic with a ladder.

(64) Instrument-undergoer: entities essential in performing an activity which are themselves the object of the activity

The biologist experimented with some frogs.

Surveying these proposals leads to several observations. Firstly, I'd like to draw attention to example (57) above where the instrument is a body part. Body-part

instruments have been mentioned only in passing. Rissman (2013) points out that writing for example can be carried out with a body-part instrument: ‘you can write with your finger in the sand’. She questions whether *the finger* plays the same role in human cognition as *a pen* might. Nilsen (2019) suggests that in a hierarchy of instruments, body parts would be higher than tools because a body part can control a tool, but not vice versa.⁴ To the best of my knowledge, only one study teased apart between tool instruments and body-part instruments explicitly. In a Stroop experiment, Doshier and Corbett (1982) provided participants with a sentence followed by a likely tool instrument (65-a) or body-part instrument (65-b):

- (65) a. The man swept the floor ... followed by ‘broom’
 b. The duck few over the pond ... followed by ‘wing’

The straightforward Stroop test found no indication that either tool or body-part instruments are activated by the sentence. However, when the speakers were asked to silently produce the most likely instrument, body-part instruments led to shorter reaction times than external instruments.⁵

Example (58-b) illustrates a case where the *with*-phrase is an adjunct by well-established diagnostics. Let us assess the status of the phrase ‘with patience’ considering Koenig et al.’s (2003) semantic obligatoriness and specificity criteria. Firstly, ‘with patience’ or any manner is not obligatory to building. Secondly, virtually anything can be done ‘with patience’, thus, it is not specific to building. Koenig et al.’s (2003) criteria identifies ‘with patience’ as adjunct.

A closer look at Schlesinger’s (2006) categories of instruments reveals that the

⁴The author does acknowledge that this is a hypothesis that requires experimental evidence.

⁵Zahedi (2012)’s (2012) study discusses the prominent role of body parts, particularly the head, in human cognition through the lens of metaphors.

relationship between a verb and its instrument is not always the same, which may be why Schlesinger (2006) divides them into categories. Consider *a knife* in a context of *cutting* versus *a ladder* in the context of *grabbing*. The relationship between *a knife* and *cutting* is salient whereas the relationship between *a ladder* and *grabbing* is not as obvious.

This section highlights that there are different types of phrases that can all be referred to as some kind of instrument. Here are examples of different instruments or instrument-like phrases: manner adverbs such as *with patience*, *external* instruments such as *with a knife*, and *body-part* instruments such as *with his nails*. The fact that instrument phrases are often treated as a unified class despite the heterogeneity within the class may contribute to their unclear status as arguments or adjuncts.

3.1.2 Instruments: arguments or adjuncts?

It is not obvious whether instruments should be classified as arguments or adjuncts (Rissman, 2013; Schütze, 1995; Koenig et al., 2003; Tutunjian and Boland, 2008, a.o.). Instrument phrases have been classified as adjuncts (Van Valin Jr and LaPolla, 1997; Sedivy and Spivey-Knowlton, 1994; Spivey-Knowlton and Sedivy, 1995; Goldberg, 2002; Dowty, 2003; Blodgett and Boland, 2004; Boland, 2005; Rissman, 2010), as arguments (Schütze, 1995; Bresnan, 1982, p. 164-165), as having a gradient representation (Rissman et al., 2015), or as conceptual participants but not syntactic arguments (Barbu and Toivonen, 2016b).

3.1.2.1 Argumenthood diagnostic tests

This section reviews several diagnostic tests proposed in the literature to differentiate between arguments and adjuncts (for an in-depth discussion, see Needham and Toivonen, 2011). Given that these tests are, for the most part⁶, successful at distinguishing between uncontroversial arguments and adjuncts, they can be used to classify controversial phrases.

Here, these argumenthood tests serve as a diagnostic tool to assess the status of instrument phrases. In what follows, we first review the description of each test. Then, we provide an example to illustrate that the test does indeed distinguish between clear arguments and adjuncts. Lastly, we ‘apply’ the test to an instrument phrase and evaluate whether it classifies the phrase as an argument or as an adjunct.

The core participants tests

As discussed in Chapter 1, Section 1.1, the core participants test relies on the meaning of the verb. Arguments are “the participants minimally involved in the activity or state expressed by the predicate” (Haegeman, 1994, p. 94) whereas adjuncts are peripheral participants (Geeraerts and Cuyckens, 2007, p. 775). Consider (66):

(66) Dan cut the ice cream cake with a knife with excitement.

This test identifies ‘Dan’ and ‘the ice cream cake’ as arguments, as they are closely related to the meaning of the verb. In contrast, ‘with excitement’ is an adjunct as it is a peripheral participant, not closely related to cutting. Based on this test,

⁶Note however that all the tests have their complications (Zaenen and Crouch, 2009; Needham and Toivonen, 2011; Dalrymple and Mycock, 2019; Jackendoff, 2010; Moura and Miliorini, 2018, a.o.).

instruments such as ‘with a knife’ are core participants, thus arguments.

Note however, that if we apply the same test to what Schlesinger (2006) refers to as abstract instruments, we may reach a different conclusion:

- (67) Dan carved the sculpture with mastery. In (67), ‘with mastery’ is a peripheral participant, thus an adjunct. In sum, the core participants test identifies some instruments as arguments and some as adjuncts.

The uniqueness/iterativity test

The iterativity (or multiple occurrence) test states that adjuncts can be iterated, whereas arguments cannot (Bresnan, 1982; Kaplan and Bresnan, 1995).

- (68) a. Jimmy saw Eminem on Tuesday in the morning.
 b. *Jimmy saw Eminem Lana Del Rey.
 c. *Jimmy cut the meat with a knife with a saw.
 d. The robot opened the door with a key with its robotic arm.

Example (68-a) illustrates that adjuncts can be iterated, whereas (68-b) illustrates that arguments cannot. The iterativity test leads to mixed results. Example (68-c) identifies instruments as arguments whereas (68-d), as Goldberg (2002) points out, identifies instruments as adjuncts.

The verb specificity test

The verb specificity test states that arguments are restricted to a verb or a class of verbs whereas adjuncts are not (Koenig et al., 2002, 2003).

- (69) a. The exchange program lasted a year.

- b. I lived in Leamington a year.
- c. I mowed the lawn with a lawn mower.

In (69-a), the duration of time is tied to the meaning of the verb *to last*, thus, ‘a year’ is an argument. In (69-b), it is not specific to the verb, thus it is an adjunct. The verb specificity test identifies instruments as arguments.

The optionality test

The optionality test (or the subcategorization test; Dowty, 1982) states that arguments are obligatory in the linguistic string whereas adjuncts are not (Tallerman, 2014, p. 98). Consider (66):

- (70)
- a. Dan cut the ice cream cake with a knife with excitement.
 - b. *cut the ice cream cake with a knife with excitement.
 - c. *Dan cut with a knife with excitement.
 - d. Dan cut the ice cream cake.

This test identifies ‘Dan’ and ‘the ice cream cake’ as arguments; omitting either renders the sentence ungrammatical (70-b, c). In contrast, ‘with excitement’ and ‘with a knife’ are optional in the linguistic string, thus, adjuncts (70-d). The optionality test identifies instruments as adjuncts.

The VP anaphora test

The VP anaphora test states that adjuncts may be added to ‘do so’ clauses, but arguments may not (Lakoff and Ross, 1976; Needham and Toivonen, 2011; Sedivy and Spivey-Knowlton, 1994). The test is rooted in the tight link between a verb and

its argument: ‘do so’ refers to the verb and its arguments, however, it does not refer to the verb and its adjunct(s) (Van Luven, 2014).

- (71) a. Dan will go to the gym today and Tavi will do so tomorrow.
 b. *Dan will fix the sink and Tavi will do so the shower.
 c. Dan will eat the pizza with a knife and a fork and Donny will do so with his fingers.

Example (71-a) illustrates two clear adjuncts, ‘today’ and ‘tomorrow’ being used in a ‘do so’ construction. The same construction is ungrammatical when attempting it with clear arguments, as the theme in (71-b). The VP anaphora test identifies instruments as adjuncts (71-c).

The ordering test

The ordering test states that adjuncts have a more free position than arguments such that prepositional adjuncts can follow prepositional arguments, but not vice versa (Sedivy and Spivey-Knowlton, 1994).

- (72) a. Dan will put his bag on the wet floor in a hurry.
 b. *Dan will put his bag in a hurry on the wet floor.
 c. Dan will put the pizza on the table with his hands.
 d. *Dan will put the pizza with his hands on the table.

A prepositional adjunct can follow a prepositional argument as in (72-a) whereas a prepositional argument cannot follow a prepositional adjunct as in (72-b). The ordering test identifies instruments as adjuncts.

The insertion of subject-oriented emphatic reflexives test

The insertion of subject-oriented emphatic reflexives test states that an emphatic reflexive may be inserted between the verb and an adjunct, but not between the verb and an argument (Sedivy and Spivey-Knowlton, 1994; Ntelitheos, 2012, p. 122).

- (73) a. *Cathy will give the book herself to Mary.
 b. Cathy will eat the green onion pancake herself with joy.
 c. Cathy will eat the green onion pancake herself with a fork.

Example (73-a) illustrates that the emphatic reflexive cannot be inserted between a verb and one of its arguments, whereas (73-b) shows that it can be inserted between the verb and an adjunct. The insertion of subject-oriented emphatic reflexives test identifies instruments as adjuncts.

Sedivy and Spivey-Knowlton (1994), Nemoto (2012), Schütze (1995), and Goldberg (2002) relied on such argumenthood diagnostic tests to gain insight into the status of instruments. Interestingly, they reached different conclusions, sometimes even based on the same tests. For example, Sedivy and Spivey-Knowlton (1994) concluded that instruments are adjuncts based on the *VP anaphora*, the *ordering*, and the *insertion of subject-oriented emphatic reflexives* tests. Schütze (1995) agreed that the *VP anaphora* and the *ordering* tests identify instruments as adjuncts. He also included the *iterativity* test, which, based on his interpretation, identifies instruments as arguments. Despite the mixed results, Schütze (1995) concluded that instruments are arguments. In justifying his conclusion, the author points out that the *VP anaphora* and the *ordering* tests are syntactic in nature, whereas the *iterativity* test is semantic. Since argumenthood is fundamentally a semantic concept, the iterativity test should

have the final say. Goldberg (2002), contrary to Schütze (1995), concluded that the *iterativity* test identifies instruments as adjuncts.

In sum, the argumenthood diagnostic tests reveal mixed findings. The core participants and verb specificity identify instruments as arguments⁷; the iterativity test is unclear; and the optionality, VP anaphora, ordering, and insertion of subject-oriented emphatic reflexives tests identify instruments as adjuncts.

3.1.2.2 Psycholinguistic evidence

Next we review experimental studies that speak to the status of instruments as arguments or adjuncts. Spivey-Knowlton and Sedivy (1995) conducted a reading experiment investigating the attachment of with-PPs. The stimuli consisted of action verbs where they manipulated the with-PP attachment site (74). In example (74-a), ‘with the rusty lock’ modifies the door; this is referred to as NP-attachment. In example (74-b), ‘with the heavy axe’ modifies the smashing; this is referred to as VP-attachment.⁸

- (74) a. NP attachment The fireman smashed the door with the rusty lock.
 b. VP attachment The fireman smashed the door with the heavy axe.

Results revealed a reliable VP attachment preference. We’ve seen a similar experi-

⁷Except for what Schlesinger (2006) calls ‘abstract instruments’. I am excluding those for the rest of the tests because they are, by most tests and accounts, manner adjuncts.

⁸For a more straightforward comparison of arguments and adjuncts, future work could compare two VP-attachments where one is an uncontroversial adjunct and one is an instrument, to see whether there is a difference in processing. In Spivey-Knowlton and Sedivy’ (1995) study, there were two factors at play: the place of attachment (VP- and NP-attachment), and the phrase type (instrument and adjunct). Potential stimuli:

- (i) a. adjunct The fireman smashed the door with anger.
 b. instrument The fireman smashed the door with the heavy axe.

mental set-up in Boland and Blodgett (2006), where the stimuli consisted of straightforward arguments and adjuncts as in (75):

- (75) The famous author mailed his revisions ...
- a. to the editor (VP argument)
 - b. for a fee (VP adjunct)

Boland and Blodgett’s 2006 takeaway was that readers spent less time on arguments (75a) than on adjuncts (75b). With this in mind, one may interpret Spivey-Knowlton and Sedivy (1995)’s results as evidence that ‘with a rusty lock’ is an argument in the VP-attachment condition, where it serves as an instrument for the verb, and an adjunct in the NP-attachment condition. Indeed, Schütze’s (1995) analysis of Spivey-Knowlton and Sedivy (1995) concluded that instruments are arguments. NP attached with-phrases are clearly modifiers whereas VP-attached with-phrases are unclear regarding their status. Since there is a difference between the two such that VP-attached NPs are processed faster, it suggests that instruments are arguments.

Interestingly, despite the evidence, Spivey-Knowlton and Sedivy (1995) argued that instruments are adjuncts, citing their previous paper, Sedivy and Spivey-Knowlton (1994). As described earlier, Sedivy and Spivey-Knowlton (1994) concluded that instruments are adjuncts based on a series of syntactic argumenthood tests. On the other hand, Spivey-Knowlton and Sedivy (1995) reported a difference between clear modifiers and instruments based on processing times. The authors’ conclusion that instruments are adjuncts, despite experimental evidence, is perhaps rooted in the assumption that syntactic argumenthood tests are more reliable in determining the status of instruments.

Barbu and Toivonen (2016b) and Barbu (2015) conducted two experiments, one capturing speakers’ semantic intuitions about verbs and their participants, and the second capturing their syntactic intuitions. They found that speakers mentioned instruments in the former but not in the latter. This suggests that instrument phrases behave as arguments at the semantic level (at least at first sight) whereas at the syntactic level they behave as adjuncts. See Table 3.1 adapted from Barbu and Toivonen (2016b):

Table 3.1: % of instrument mentions in a semantic and a syntactic task

Verb	Semantic	Syntactic
scratch	39%	0%
scrape	47%	0%
paint	80%	0%
sketch	85%	0%
write	90%	0%
scrub	95%	0%
cut	95%	0%
draw	100%	5%

These results reveal high variability across verbs at the semantic level. Thus, while it is clear that instrument phrases behave differently at the semantic than the syntactic level, the conclusion is not as straightforward as saying that they are semantic arguments and syntactic adjuncts.

3.1.2.3 Takeaway

This concludes our review of the status of instruments with respect to the argument/adjunct distinction. Sections 3.1.2.1 and 3.1.2.2 highlight that different approaches and assumptions lead to different conclusions about the status of instruments as arguments or adjuncts. This is not surprising given that so far there is

no agreed upon criterion for distinguishing between arguments and adjuncts (Vater, 1978; Croft and Croft, 2001; Koenig et al., 2002; Dowty, 2003; Rissman, 2013) and the field is in need of a reliable criterion (Moura and Miliorini, 2018).

3.1.3 Instruments and the allow/require distinction

Koenig et al. (2003) propose that instruments are particularly difficult to classify as arguments or adjuncts because they are treated as a unified category. The authors suggest that there are in fact two classes of instrument verbs, one consisting of verbs which require an instrument (*require-instrument*), and one consisting of verbs which merely allow the presence of an instrument (*allow-instrument*) (Koenig et al., 2003, 2008; Rissman et al., 2015). Consider the verbs *chop* and *eat*. *Chop* denotes an activity which cannot be carried out without an instrument such as a knife, whereas *eat* denotes an activity which may use utensils such as a spoon, but it does not have to.

To the best of my knowledge, there are only a handful of studies investigating the allow/require distinction: Koenig et al. (2003), Koenig et al. (2008), Rissman (2013), and Rissman et al. (2015). In an early experiment by Koenig et al. (2003), a pair of trained linguists surveyed 4200 verbs answering the following two questions:

- “Does one of the verb’s senses describe situations in which one participant must or can *use* another participant to perform an action (e.g. does *Marc cut the chicken* require or allow Marc to have used something)?”
- “Does one of the verb’s senses describe situations in which one participant must or can perform the action described by the verb *with* something (e.g. does *Marc cut the chicken* require or allow Marc to cut it with something)?”

Verbs for which the raters responded *yes, it must* to both questions were classified as *require*-instrument, and verbs for which the raters responded *yes, it can* were classified as *allow*-instrument. Verbs pertaining to these two classes then served as stimuli in a second experiment, a region by region reading time paradigm. English speaking undergraduates were presented sentences with *require*-instrument verbs (76-a) and *allow*-instrument verbs (76-b):

- (76) a. With which sword did the rebels behead the traitor king?
 b. With which sword did the rebels kill the traitor king?

Sentences with *require*-instrument verbs were read faster than sentences with *allow*-instrument verbs, providing evidence for two distinct classes of instrument verbs (Koenig et al., 2003).

Koenig et al. (2008) analyzed the properties of the verbs pertaining to the two classes. The analysis revealed that *allow*-instrument verbs were less similar to each other in meaning than *require*-instrument verbs. Secondly, the instruments themselves and the role played by the instruments was closer across *require* verbs than across *allow* verbs. Thirdly, *allow* instruments were found to be less informative and to allow more variation across the situations to which they felicitously apply.

Rissman (2013) and Rissman et al. (2015) conducted three experiments investigating the *allow/require* distinction and whether instruments are more likely to be an argument for *require*-instrument verbs than for *allow*-instrument verbs.

Two of the experiments elicited speakers' judgements about a verb's arguments. Speakers were instructed about the notion of *argument*. They were told that a verb such as *wanting* takes two participants: someone wanting and something being wanted. The stimuli consisted of sentences which contrasted instruments and

adjuncts (77-a), recipients and adjuncts (77-b), as well as adjuncts and adjuncts (77-c). To show the effectiveness of the task, the authors pitted direct object against adjuncts (77-d).

- (77) a. Martha CHOPPED something [with a bread knife] [in the operating room].
 b. John SERVED something [to the musicians] [gracefully].
 c. Chris DREW something [passionately] [at school].
 d. Jim CARRIED [the books] [in a tote bag].

The speakers' task was to consider the phrases marked by brackets and choose the argument, if any. For example, in (77-b), [to the musicians] is an argument and [gracefully] is an adjunct. In (77-c), neither bracketed phrase is an argument, thus the answer would be *neither*.

When contrasting direct objects and adjuncts, direct objects were identified as the argument 97% of the time, suggesting that the instructions were effective at distinguishing uncontroversial arguments from uncontroversial adjuncts. Overall, direct objects were preferred over recipients, and recipients over instruments. When comparing instruments and adjuncts, the instrument was identified as argument in 35% of the trials in the case of *require*-instrument verbs, and in 21% of the trials in the case of *allow*-instrument verbs. In the remaining trials, neither of the bracketed phrases were identified as arguments.

In the second experiment, speakers received the same training, but instead of viewing sentences, they were asked “what is/are the argument(s) of chop.” Speakers typed their answers in a box on a computer screen with no time limit. Compared to the first experiment, speakers were less likely overall to list an instrument as an

argument. Speakers listed an instrument on 13% of the trials for *require*-instrument verbs and on 3% of the trials for *allow*-instrument verbs.

In a third experiment, Rissman, 2013 no longer trained speakers as to what an argument is. Given the same stimuli as in the previous two studies, speakers were asked to consider the meaning of each bracketed phrase and determine which phrase was most important in the sentence. Interestingly, instruments were selected as important more often than they were selected as arguments in the previous two studies (on 51% of the trials), however, the allow/require distinction was no longer significant.

The two experiments where speakers were trained as to what arguments are provide some support for the allow/require distinction such that speakers were more likely to identify an instrument as argument for *require*-instrument verbs than for *allow*-instrument verbs. In contrast, the third experiment reveals that instruments are more important than adjuncts overall, regardless of whether they require or merely allow for an instrument.

3.1.3.1 Takeaway

This section begins to uncover why instruments are particularly difficult to classify as arguments or adjuncts. Instruments are more likely to be perceived as arguments for *require*-instrument verbs than for *allow*-instrument verbs.

Chapter 4

Instruments cross-linguistically

This chapter investigates the status of instruments as arguments or adjuncts in English, Spanish, Romanian, and Turkish. These languages were chosen for both theoretical and practical considerations. From a theoretical perspective, the four languages were chosen because of select differences and similarities amongst them. English is not a pro-drop¹ language, Spanish and Romanian are subject pro-drop, whereas Turkish is both subject and object pro-drop. Spanish and Romanian have additional similar grammatical features such as clitic options in dative and accusative and are both descendant from Latin, with a high degree of similarity. For example, Gheorghiu (2009) found that Spanish speaking students with no knowledge of Romanian translated a Romanian text of intermediate difficulty into Spanish quickly and with a high degree of accuracy. From a typological variety, English is analytical, Spanish and Romanian are fusional, whereas Turkish is agglutinative.

From a practical perspective, Romanian and Spanish were chosen because I am a

¹Pro-drop (pro from pronoun) refers to the omission of a certain class of phrases (often subjects) in a language when the referent is pronominal.

native speaker of the former and have native-like fluency in the latter. Turkish was chosen because of close collaboration with Lara Russo, a Linguistics undergraduate student at the time, who is a native speaker of Turkish.

This cross-linguistic exploration assesses instruments from both a semantic and a syntactic perspective and explores whether the allow/require distinction proposed by Koenig et al. (2003) may help explain the controversial status of instruments. Though Rissman's (2013), Koenig et al.'s (2003, 2008) and the present study all explore the status of instruments by eliciting speakers' intuitions, they differ in their methodologies. Rissman (2013) provided speakers with explicit training as to what arguments are. Koenig et al. (2003, 2008) relied on trained linguists to classify instrument verbs as either requiring an instrument, or merely allowing one. One limitation of Rissman and Koenig et al.'s approaches is that they relied on current definitions of argumenthood, which as we saw in Chapter 3, are not successful at classifying instruments as arguments or adjuncts. With respect to the tasks themselves, both Rissman (2013) and Koenig et al. (2003, 2008) presented their stimuli in a sentence format, though they were aiming to elicit the speakers' semantic intuitions. The sentence format of the stimuli may have biased speakers to rely on their syntactic judgements, despite the authors' intentions to capture semantic intuitions.

Rissman (2013) and Koenig et al. (2003, 2008) paved the way to exploring the heterogeneity of instrument verbs by proposing that they are not a unified class, but divided in *require*-instrument and *allow*-instrument verbs, respectively.

Section 4.1 reviews the goals of the cross-linguistic investigation. Sections 4.2-4.5 present the methods, results and discussion for each language. Readers not interested in the details of specific languages may skip ahead to Section 4.6, which provides an

overview of the status of instruments cross-linguistically and can be read in isolation.

4.1 Goals of the present study

The present study investigated the status of instruments as arguments or adjuncts and asked the following questions:

- What is the status of instruments at the semantic and syntactic levels, respectively?
- Do instrument verbs form a unified class or are they divided into verbs that require an instrument and verbs that merely allow an instrument?
- Do instrument verbs encode an instrument the same way ditransitive verbs encode an indirect object?
- Do these instrument characteristics hold cross-linguistically?

4.2 The status of instruments in English

4.2.1 Methods

Subjects

A hundred and forty-two self-reported native speakers of English (95 F, 46 M, 1 unspecified) were recruited from Carleton University using the school's Cognitive Science recruitment system. To be eligible, they had to be English-speaking and at least 18 years of age. Aside from age range and gender, we also asked speakers at

what age they started learning English. Incomplete answers were excluded (e.g., if speakers completed only the demographic questionnaire and not the language task). As compensation for their participation, the students received 0.75% class credit towards a psychology or neuroscience course. Table 4.1 provides a breakdown by experiment and age group.

age group	Experiment	
	semantic	syntactic
18 - 22	55	72
23 - 40	6	5
40 and over	1	2
unspecified	1	0

Table 4.1: Speakers' age by experiment

Design, materials and instructions

The study consisted of two experiments, one tapping into the speakers' semantic intuitions, and one into their syntactic intuitions.

In the first experiment, speakers were instructed to *imagine* an event such as *devouring* taking place in a large, empty box. They were asked to type the participants necessary for the event to occur in an open-ended, not timed, text field. Speakers were presented with three types of trials: transitive instrument verbs, transitive non-instrument verbs, and ditransitive verbs. Transitive verbs such as *chase*, *kick*, and *pinch* take two semantic arguments. Ditransitive ones such as *deliver*, *send*, and *persuade* take three semantic arguments.

In the case of instruments, the number of arguments is influenced by the status of the instrument. Consider the verb *to chop*. If the instrument is an argument, then we would say *to chop* is a three-argument verb (someone chopping, something being

chopped, something to chop with). If the instrument is an adjunct, then *to chop* is a two-argument verb (someone chopping, something being chopped). The hypothesis is that for some verbs, the instrument is an argument (e.g., ‘a knife’ in *cut the bread with a knife*) whereas for others, the instrument is an adjunct (e.g., ‘a spoon’ in *ate the soup with a spoon*). Instrument verbs were divided into *require*-instrument verbs and *allow*-instrument verbs. A complete list of the stimuli is included in Appendix A. Translations of these verbs were used in the Spanish, Romanian, and Turkish studies.

The instrument verbs used in this study were classified by Koenig et al. (2008) and Rissman (2013). For the verbs classified by both, there was agreement as to whether the verb required or merely allowed an instrument with the exception of the verb *paint* which was classified as requiring an instrument by Koenig et al. (2008) and as allowing an instrument by Rissman (2013).² Table 4.2 illustrates the instructions for experiment one:

²Rissman (2013) states that the verbs she used as stimuli follow Koenig et al.’s (2008) classification with the exception of the verbs *touch*, *lift*, *clean*, *wash*, and *grow*, which she classified herself. This suggests that classifying *paint* as allowing rather than requiring an instrument was merely an oversight rather than disagreement with Koenig et al.’s (2008) classification.

Imagine the following events taking place in a large, **empty** box. What **must** (**needs to**) be in the box (people, objects/things, places etc.) for the given events to take place?

For example, given a **devouring** event, a potential answer is:

1. someone to devour and something to be devoured (a man and a pizza)

Similarly, given a **serving** event, potential answers are:

1. someone to serve and something to be served (a waiter and a cold soup)
 2. someone to serve, something to serve, and someone to be served (a waiter, a cold soup, and a woman)
 3. someone to serve and someone to be served (a waiter and a woman)
-

Table 4.2: Experiment 1 - eliciting speakers' semantic intuitions

In experiment two, speakers were presented with the beginning of a sentence and instructed to add at least a word to complete it. The verb stimuli were the same across the two experiments. Table 4.3 illustrates the instructions for experiment two:

Given these phrases, please add at least one word **to complete** each sentence. For example, given the phrase **The man devoured**, a potential answer is:

1. The man **devoured** a pizza.

Similarly, given the phrase **The waiter served**, potential answers are:

1. The waiter **served** a cold soup.
 2. The waiter **served** a cold soup to the woman.
 3. The waiter **served** the woman.
-

Table 4.3: Experiment 2 - eliciting speakers' syntactic intuitions

4.2.2 Results

This section presents the results for the semantic and syntactic experiments in English. We started by exploring the speakers' production of adjuncts. Next, we explored the linguistic participants produced by experiment (semantic/syntactic) and class (transitive/ditransitive/allow/require). Lastly, we compared instruments and indirect objects to see whether instrument verbs encode instruments the same way ditransitives encodes indirect objects.

Adjunct production as a measure of experiment validity

Mentions of adjuncts or lack thereof speak to the success of the two experiments in capturing the speakers' semantic and syntactic intuitions about core and/or salient participants only. The lower the mentions of uncontroversial adjuncts, the more likely it is that the experiments indeed assessed what we intended. For the purpose of this analysis, adjuncts refer to traditionally accepted adjuncts such as time, place, manner, and do not include mentions of instruments. Table 4.4 provides an overview of the percentage of responses containing adjuncts by experiment.

Experiment	Adjuncts (%)
semantic	3.53%
syntactic	5.84%

Table 4.4: Adjunct mentions by experiment

The results for the semantic experiment are particularly impressive given the free and open-ended nature of the instructions. Overall, responses suggest that the two experiments were effective at distinguishing between core/salient participants and adjuncts. We aimed to elicit mentions of core and salient participants, but not mentions

of adjuncts. The fact that less than 6% of the responses include adjunct mentions per experiment suggests we were successful.

Overview of participants

As we saw in Tables 4.2-4.3, speakers were given the subject in the syntactic experiment, but not in the semantic one. For that reason, we excluded the subject from our analysis. Consider the verb *to show*. A response such as ‘the teacher, the solution, the student’ in the semantic experiment was coded as having two participants: ‘the solution’ and ‘the student’. For the rest of this chapter, whenever we say *participants*, we refer to the direct object, indirect object, and instrument in the case of instrument verbs.

Overall, the number of participants mentioned was similar across the two experiments (semantic: $M = 1.22$, $SD = 0.67$; syntactic: $M = 1.07$, $SD = 0.26$) with a greater variability in the semantic experiment, as indicated by the standard deviation. Figure 4.1 illustrates the overall pattern of participant mentions.

Figure 4.1: Participants by experiment and verb class

Figure 4.1 shows the data distribution, the mean, and the median. All four verb types elicited the same median in both the semantic and the syntactic experiments, as indicated by the horizontal line. Within the semantic study, *ditransitives* and *require*-instrument verbs patterned together with higher means (indicated by the *) and higher variability than *transitives* and *allow*-instrument verbs. In the syntactic experiment, *ditransitives* continued to elicit higher number of participants and higher variability, whereas *require*-instrument verbs patterned with *allow*-instrument verbs and *transitives* in terms of median, mean, and variability.

Further analyses explored the relationship between the number of participants, experiment, and class using linear mixed-effects regression models (lmer) in R. Class (transitive, ditransitive, allow, require) and experiment (semantic, syntactic) were included as fixed effects. Speaker was included as a random effect. The number of participants was the dependent variable.

The analysis revealed a main effect of class ($\chi^2 = 1452.22$, $p < .001$), a main effect of experiment ($\chi^2 = 29.05$, $p < .001$), and a class*experiment interaction ($\chi^2 = 469.90$, $p < .001$). We followed up on the interaction by examining the simple effects for each verb class. Of interest are the transitive/ditransitive and the allow/require comparisons. Verbs in the transitive/ditransitive conditions differed significantly from each other with ditransitives eliciting more participants than transitives in both experiments (semantic, $z = 26.38$, $p \leq .0001$; syntactic, $z = 28.01$, $p \leq .0001$). Verbs in the allow/require conditions differed significantly in the semantic experiment with *require*-instrument verbs eliciting more participants than *allow*-instrument verbs (semantic, $z = 11.75$, $p \leq .0001$). They did not differ in the syntactic experiment (syntactic, $z = 0.02$, $p = 1.00$). Figure 4.2 illustrates the class*experiment interaction:

Figure 4.2: Class*experiment interactions for the number of linguistic participants

As illustrated in Figure 4.2, speakers' responses differ across verb classes and experiments. Next we further explore these differences by comparing speakers' responses in the transitive/ditransitive verb classes, and in the allow/require respectively.

Transitive/Ditransitive verbs

The number of participants

Since ditransitives take two internal arguments (e.g., *give* takes an object and a receiver) and transitives take one (e.g., *spill* takes what is being spilled), we predicted ditransitives will elicit more participants than transitives. Secondly, since not all participants have to be expressed in the linguistic string, we anticipate more participant mentions in the semantic experiment than in the syntactic one. Table 4.5 provides a descriptive summary of participants by class and experiment.

	Semantic		Syntactic	
Class	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
transitive	1.01 (<i>0.44</i>)	1	1.00 (<i>0.03</i>)	1
ditransitive	1.35 (<i>0.77</i>)	1	1.29 (<i>0.46</i>)	1

Table 4.5: Number of participants by experiment and by verb class

As shown in Table 4.5, ditransitives indeed elicited more participant mentions than transitives in both experiments. Table 4.6 illustrates participant mentions in transitive verbs.

	Participants (%)		
Experiment	do	io	do and io
semantic	98.72%	*2.24%	*0.96
syntactic	100%	*0.07%	*0.07

Table 4.6: Mentions of participants by experiment in transitive verbs

As shown in Table 4.6, most transitives elicited a participant corresponding to the direct object. This trend was more prominent in the syntactic experiment than in the semantic one. The star (*) in the table indicates that some speakers mentioned indirect objects for some of the verbs classified a priori as transitive. Transitive verbs do not take an indirect object, thus, these results seemed intriguing at first. These were traced back to the verb *to say*, which we classified as transitive, in contrast to *to tell*, which we classified as ditransitive. Some speakers treated both verbs as ditransitive, mentioning what is being said and to whom. Table 4.7 illustrates participant mentions in ditransitive verbs.

	Participants (%)		
Experiment	do	io	do and io
semantic	82.20%	52.98%	35.18
syntactic	88.04%	41.60%	29.65

Table 4.7: Mentions of participants by experiment in ditransitive verbs

As shown in Table 4.7, more than 80% of the ditransitive verbs elicited a participant corresponding to the direct object, and once again, the direct object was mentioned more frequently in the syntactic experiment. The recipient was mentioned in approximately half of the responses. These results suggest that at least some verbs are ditransitive, and this requirement is both semantic and syntactic.

Allow/Require verbs and the status of instruments

While the argument/adjunct distinction is often clear and intuitive, classifying instruments as either arguments or adjuncts has proven difficult. Koenig et al. (2002, 2003, 2008) propose that this may be in part due to the fact that instrument verbs do not form a homogeneous class though they are often treated as one. To address this, they propose the allow/require distinction: some verbs require an instrument whereas others merely allow it. This section explores the allow/require distinction at the semantic and syntactic level.

The number of linguistic participants

Table 4.8 provides a descriptive summary of the participants produced by experiment (semantic/syntactic) and class (allow/require).

	Semantic		Syntactic	
Class	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
allow	1.18 (<i>0.65</i>)	1	1.00 (<i>0.03</i>)	1
require	1.32 (<i>0.74</i>)	1	1.00 (<i>0.00</i>)	1

Table 4.8: Number of participants by experiment, by verb class

Speakers produced more participants in the semantic experiment than in the syntactic one. They also produced more participants for *require*-instrument verbs than for

allow-instrument verbs. Similar to the transitive/ditransitive comparison, we see more variability in the semantic experiment compared to the syntactic one.

The types of participants

When comparing transitive and ditransitive verbs, we explored whether speakers mentioned more participants for ditransitives than for transitives. When comparing *require*- and *allow*-instrument verbs, we explore a similar relationship. *Require*-instrument verbs must take an instrument whereas *allow* ones merely allow it. If this distinction is real, we would expect *require*-instrument verbs to elicit more participants than *allow*-instrument verbs. If it is not real, we expect no difference in instrument mentions between the two verb classes. Table 4.9 illustrates direct object and instrument mentions in *allow*- and *require*-instrument verbs.

Class	Experiment	Linguistic participants	
		do	instrument
allow	semantic	82.93%	32.11%
	syntactic	100%	0.29%
require	semantic	69.52%	58.48%
	syntactic	100%	0.53%

Table 4.9: Mentions of participants by experiment in *allow* and *require* verbs

Table 4.9 shows that the direct object was mentioned by most speakers in both experiments, with more mentions in the syntactic experiment than in the semantic one. Instruments, however, were elicited in the semantic experiment by some speakers and virtually unmentioned in the syntactic one, consistent with previous results (Barbu, 2015; Barbu and Toivonen, 2016a,b). Within the semantic experiment, *require*-instrument verbs elicited more instrument mentions than *allow*-instrument verbs.

Further analyses were conducted for the mentions of instruments, experiment, and class using mixed-effects logistic regression models in R. Class and experiment were included as fixed effects and speaker as a random effect. The mentions of instruments (categorical; yes/no) was the dependent variable.

For mentions of instruments, there was a main effect of experiment ($\chi^2 = 119.96$, $p \leq .001$) with instruments being more prevalent in the semantic experiment than in the syntactic one. There was also a main effect of class ($\chi^2 = 85.83$, $p \leq .001$), with *require*-instrument verbs eliciting more instrument mentions than *allow*-instrument verbs; and a class*experiment interaction ($\chi^2 = 21.76$, $p \leq .001$) such that *require*-instrument verbs elicited more instruments than *allow*-instrument verbs in the semantic experiment ($z = 14.13$, $p \leq .0001$), whereas in the syntactic one there were no differences ($z = 0.99$, $p = 0.98$). Figure 4.3 provides a visualization of the relations described above, illustrating the mean rates of choosing an instrument by experiment and class.

Figure 4.3: Mean rates of choosing instruments by experiment and class

Figures 4.4 and 4.5 illustrate the percentage of the speakers who mentioned an instrument for a given verb in the semantic and syntactic experiment, respectively. Additionally, they illustrate whether the allow/require distinction holds in English.

Figure 4.4: Allow/require instruments in the semantic experiment

Figure 4.5: Allow/require instruments in the syntactic experiment

Figures 4.4 and 4.5 provide some support for the allow/require distinction, though this distinction seems to be gradual rather than categorical. Additionally, some verbs do not pattern within their expected category. Looking at the semantic experiment, the verb *clean* was classified as allowing an instrument, however, it patterned with verbs requiring an instrument. The verbs *hit*, *dissect*, *beat*, *scratch* and *touch* were classified as requiring an instrument, but patterned with *allow*-instrument verbs. Interestingly, the action described by these verbs except *dissect* could be carried out with a body part as an instrument, suggesting that body-part instruments may be perceived differently than external instruments.

In the syntactic experiment, instrument mentions were negligible in both *require* and *allow* verb classes.

Comparing instruments and indirect objects

If instruments are true arguments, a fair comparison would be between mentions of instruments for allow/require verbs and indirect objects for ditransitive verbs. Tables 4.10 and 4.11 compare mentions of instruments for instrument verbs and mentions of indirect objects for ditransitives.

	verb class	%
instruments	allow	0.29
	require	0.53
indirect objects	ditransitive	41.60

Table 4.10: Mentions of instruments in require/allow and indirect objects in ditransitives in the syntactic experiment

	verb class	%
instruments	allow	32.11
	require	59.48
indirect objects	ditransitive	52.98

Table 4.11: Mentions of instruments in require/allow and indirect objects in ditransitives in the semantic experiment

Tables 4.10 and 4.11 show that while indirect objects are mentioned both in the semantic and the syntactic experiments, instruments are only mentioned in the semantic experiment. In other words, though they have a prominent status in human cognition, they have different characteristics than both arguments and adjuncts. As to the allow/require distinction, speakers have mentioned significantly more instruments for *require*-instrument verbs than for *allow*-instrument verbs.

4.2.3 Interim summary

The two studies were successful at teasing apart core/salient participants and adjuncts, as suggested by the low mention of adjuncts and high mention of direct objects across the four verbs classes. Instruments were prevalent in the semantic experiment, but negligible within the syntactic one (less than 1% mentions). Within the semantic experiment, instrument mentions were significantly higher for *require*-instrument verbs than for *allow*-instrument verbs.

4.3 The status of instruments in Romanian

This chapter investigates the status of instruments as arguments or adjuncts in Romanian. We conducted two studies: one investigated the status of instruments at the semantic level, and the other investigated their status at the syntactic level. As in

English, the stimuli were classified as transitive, ditransitive and instrument verbs. Instrument verbs were further classified into *require*-instrument verbs where the instrument is necessary to carry out the action, and *allow*-instrument verbs where an instrument may be used but doesn't have to. We investigated whether speakers were more likely to mention an instrument for a *require*-instrument verb than for an *allow*-instrument verb. We asked whether potential semantics/syntax mismatches along with the allow/require distinction may help explain why it is difficult to classify instruments as arguments or adjuncts.

4.3.1 Methods

Subjects

A hundred and fourteen self-reported native speakers of Romanian (77 F, 37 M) were recruited through the researchers' social media platforms and snowballing. I posted a description of the study and invitation in Romanian which targeted native speakers of Romanian. To be eligible, they had to be Romanian-speaking and at least 18 years of age. Aside from age range and gender, we also asked speakers at what age they started learning Romanian. Incomplete answers were excluded (e.g., if speakers completed only the demographic questionnaire and not the language task). Table 4.12 provides a breakdown by experiment and age group.

age group	Experiment	
	semantic	syntactic
18 - 22	31	4
23 - 40	15	25
40 and over	13	26

Table 4.12: Speakers' age by experiment

Design, materials and instructions

The design and materials are the same as in the English study and are discussed in detail in Chapter 4.2. The instructions and a complete list of the stimuli and their translations are included in Appendix B.

4.3.2 Results

This section explores mentions of participants in Romanian. We first explored the overall production of adjuncts. Then we explored mentions of participants by class (transitive/ditransitive/allow/require). Lastly, we compared instruments and indirect objects to see whether instrument verbs encode instruments the same way ditransitive verbs encode indirect objects.

Adjunct production as a measure of experiment validity

Our aim was to elicit mentions of core and salient participants only. If the instructions were successful, one would expect negligible mentions of uncontroversial adjuncts such as time, place, and manner. The lower the mentions of adjuncts, the more likely it is that the experiments assessed what we intended. Table 4.13 provides the proportions of adjunct mentions averaged across verbs and speakers by experiment.

Experiment	Adjuncts (%)
semantic	3.30%
syntactic	5.10%

Table 4.13: Adjunct mentions by experiment

Overall, the results suggest that the instructions for the two experiments were effective at teasing apart speakers' intuitions about core/salient participants and adjuncts.

Our intention was to lead speakers to mention core and salient participants but not adjuncts. The instructions were effective with less than 6% adjunct mentions per experiment.

Overview of participants

As in the English study, speakers were given the subject in the syntactic experiment, but not in the semantic one. For that reason, we excluded the subject from our analysis. Consider the verb *a scrie* (*to write*). A response such as *studentul, o poezie, un creion* (*the student, a poem, a pencil*) in the semantic experiment was coded as having two participants: *o poezie* (*the poem*) and *un creion* (*a pencil*). For the remainder of the chapter, the term *participants* refers to direct objects across all verb classes, indirect objects for ditransitive verbs, and instruments for instrument verbs.

Overall, the number of participants mentioned was similar across the two experiments (semantic: $M = 1.27$, $SD = 0.60$; syntactic: $M = 1.03$, $SD = 0.23$) with a greater variability in the semantic experiment, as indicated by the standard deviation. Figure 4.6 illustrates the overall pattern of participant mentions.

Figure 4.6: Participants by experiment and verb class

Figure 4.6 shows the median, mean, and variability of the data. It reveals the following overall generalizations: within the semantic experiment, *require*-instrument verbs had the highest median (med = 2), whereas *transitives*, *ditransitives*, and *allow*-instrument verbs had the same median (med = 1). In terms of mean (*) and data distribution, *ditransitives*, *require*- and *allow*-instrument verbs patterned together with values higher than *transitives*. In the syntactic experiment, all four verb classes patterned together.

Further analyses were conducted to explore the relationship between the number of participants, experiment, and class using linear mixed-effects regression models (lmer) in R. Class (transitive, ditransitive, allow, require) and experiment (semantic, syntactic) were included as fixed effects. Speaker was included as a random effect. The number of participants was the dependent variable.

The analysis revealed a main effect of class ($\chi^2 = 899.16$, $p < .001$), a main effect of experiment ($\chi^2 = 66.18$, $p < .001$), and a class*experiment interaction ($\chi^2 = 741.53$, $p < .001$). We followed up on the interaction by examining the simple effects for each verb class. Of interest were the transitive/ditransitive and the allow/require comparisons. Verbs in the transitive/ditransitive conditions differed significantly from each other with ditransitives eliciting more participants than transitives in both experiments (semantic, $z = 27.41$, $p \leq .0001$; syntactic, $z = 7.97$, $p \leq .0001$). Verbs in the allow/require conditions differed significantly in the semantic experiment with *require*-instrument verbs eliciting more participants than *allow*-instrument verbs ($z = 176.26$, $p \leq .0001$) but not in the syntactic one ($z = 0.28$, $p = 1.00$). Figure 4.7 illustrates the class*experiment interaction:

Figure 4.7: Class*experiment interactions for the number of participants

Figure 4.7 shows that speakers' responses differ across verb classes and experiments. Next, we investigated these differences in detail by comparing speakers' responses in the transitive/ditransitive and in the allow/require verb classes, respectively.

Transitive/Ditransitive verbs

The number of participants

Since ditransitive verbs take two internal arguments (e.g., *pass* takes an object and a receiver) and transitive verbs take one (e.g., *kiss* takes the person being kissed), we expected ditransitive verbs to elicit more participants than transitive ones. Secondly, since not all participants must be expressed in the linguistic string, we anticipated more participant mentions in the semantic experiment than in the syntactic one.

Table 4.14 provides a descriptive summary of participants by class in the semantic and the syntactic experiment, respectively.

	Semantic		Syntactic	
Class	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
transitive	0.92 (0.43)	1	0.99 (0.13)	1
ditransitive	1.34 (0.63)	1	1.12 (0.35)	1

Table 4.14: Number of participants by experiment and by verb class

Table 4.14 shows that ditransitive verbs elicited more participant mentions than transitive ones in both experiments, as predicted. Table 4.15 illustrates participant mentions in transitive verbs.

	Participants (%)
Experiment	do
semantic	91.43%
syntactic	98.70%

Table 4.15: Mentions of participants by experiment in transitive verbs

Table 4.15 shows that most transitive verbs elicited a participant corresponding to the direct object. This trend was more prominent in the syntactic experiment than in the semantic one.³ Table 4.16 illustrates participant mentions in ditransitive verbs.

	Participants (%)		
Experiment	do	io	do and io
semantic	71.52%	62.67%	35.21
syntactic	72.94%	39.16%	12.96

Table 4.16: Mentions of participants by experiment in ditransitive verbs

Table 4.16 illustrates that more than 70% of the responses elicited a participant corresponding to the direct object. The indirect object was mentioned more often in

³As in the English study, Romanian speakers also treated some transitive verbs (less than 1%) as ditransitive (e.g., *a zice/to say* and *a vărsa/to spill*). As in English, some speakers treated both *a zice/to say* and *a povesti/to tell* as ditransitive, mentioning the listener for both. The verb *a vărsa/to spill* was interpreted as *to spill* by some speakers and as *to pour* by others. *To pour* is indeed a ditransitive verb.

the semantic experiment than the syntactic one. These results suggest that at least some verbs are ditransitive, and this requirement is both semantic and syntactic.

Allow/Require verbs and the status of instruments

The allow/require distinction may help explain the controversial status of instruments (Koenig et al., 2002, 2003, 2008; Rissman et al., 2015). This study is the first to explore this distinction in Romanian.

The number of linguistic participants

Table 4.17 provides a descriptive summary of the participants produced by experiment (semantic/syntactic) and class (allow/require).

	Semantic		Syntactic	
Class	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
allow	1.28 (<i>0.54</i>)	1	1.00 (<i>0.18</i>)	1
require	1.53 (<i>0.63</i>)	2	2.00 (<i>0.16</i>)	1

Table 4.17: Number of participants by verb class and experiment

Verbs in the *allow* and *require* classes led to similar findings in English and Romanian such that the semantic experiment elicited more participants than the syntactic one. Similarly, *require* verbs elicited more participants than *allow* verbs. Once again, we see more variability in the semantic experiment than in the syntactic one.

The types of participants

Since the instrument verbs included in this study were transitive, direct objects should be mentioned in the majority of responses regardless of the condition. If the allow/require distinction is psychologically real, we would expect *require*-instrument

verbs to elicit more instrument mentions than *allow*-instrument verbs. Table 4.18 illustrates direct object (do) and instrument mentions in *allow*- and *require*-instrument verbs.

		Participants	
	Experiment	do	instrument
allow	semantic	90.67%	34.23%
	syntactic	97.76%	1.02%
require	semantic	82.74%	68.70%
	syntactic	98.52%	1.67%

Table 4.18: Mentions of participants by experiment in allow and require verbs

Table 4.18 shows that the direct object was mentioned by the majority of the speakers in both the semantic and the syntactic experiment suggesting that the experimental design was successful at eliciting core participants. Instruments were mentioned in the semantic experiment but not in the syntactic one, consistent with previous results based on English data (Barbu, 2015; Barbu and Toivonen, 2016a,b) and the English study presented in Section 4.2 above. Within the semantic one, *require*-instrument verbs elicited approximately twice as many instrument mentions than *allow*-instrument verbs.

Further analyses were conducted for the mentions of instruments, experiment, and class using mixed-effects logistic regression models in R. Class and experiment were included as fixed effects and speaker as a random effect. The mentions of instruments (categorical; yes/no) was the dependent variable.

For mentions of instruments, there was a main effect of experiment ($\chi^2 = 170.68$, $p \leq .001$) with instruments being more prevalent in the semantic one than in the syntactic one. There was also a main effect of class ($\chi^2 = 115.95$, $p \leq .001$), with *require* verbs eliciting more instrument mentions than *allow* verbs; and a class*experiment

interaction ($\chi^2 = 32.26$, $p \leq .001$) such that *require*-instrument verbs elicited more instruments than *allow*-instrument verbs in the semantic experiment ($z = 16.52$, $p \leq .0001$), whereas in the syntactic one there were no differences ($z = 1.29$, $p = 0.90$).

Figure 4.8 provides a visualization of the relations described above, illustrating the mean rates of choosing an instrument by experiment and verb class.

Figure 4.8: Mean rates of choosing instruments by experiment and class

Figures 4.9 and 4.10 illustrate the percentage of the speakers who mentioned an instrument for *require*- and *allow*-instrument verbs in the semantic and syntactic experiments.

Figure 4.9: Allow/require instruments in the semantic experiment

Figure 4.10: Allow/require instruments in the syntactic experiment

Figures 4.9 and 4.10 provide some support for the allow/require distinction, though once again we see that the distinction is gradual, not categorical, consistent with the English data discussed in Chapter 4.2. Some verbs did not pattern within their predicted category. In the semantic experiment, the verbs *paint*, *clean*, and *wash* were classified as *allow*-instrument but patterned with *require*-instrument verbs. The verbs *touch*, *beat*, *hit*, *stir*, and *scratch* were classified as *require* verbs and patterned with *allow*. Interestingly, the action described by these verbs except perhaps *stir* could be carried out with a body part. This suggests that instruments denoting a body part may be perceived differently than external instruments. This is consistent with the English results reported in Section 4.2 above. In the syntactic experiment, instrument mentions were negligible for both *require*-instrument and *allow*-instrument verbs.

Comparing instruments and indirect objects

If instruments are arguments, one may expect them to pattern with the indirect objects for ditransitive verbs.

	verb class	%
instruments	allow	1.02
	require	1.67
indirect objects	ditransitive	39.16

Table 4.19: Mentions of instruments in require/allow and indirect objects in ditransitives in the syntactic experiment

	verb class	%
instruments	allow	34.23
	require	68.70
indirect objects	ditransitive	62.67

Table 4.20: Mentions of instruments in require/allow and indirect objects in ditransitives in the semantic experiment

Tables 4.19 and 4.20 show that while indirect objects were mentioned both in the semantic and the syntactic experiments, instruments were only mentioned in the semantic experiment. In other words, though salient in human cognition, instruments do not clearly pattern with either arguments nor adjuncts. As for the allow/require distinction, instruments were more prominent in *require*-verbs than in *allow*-verbs.

4.3.3 Interim summary

The findings presented above reveal a low production of adjuncts and a high production of direct objects in both experiments in all four verb classes. Thus, the instructions were successful at dissociating core and peripheral participants and eliciting mentions of core/salient participants and not adjuncts, as intended. Similar to the English study, instruments were mentioned in the semantic experiment but not in the syntactic one (less than 2% mentions). Within the semantic experiment, *require*-instrument verbs elicited significantly higher mentions of instruments than *allow*-instrument verbs.

4.4 The status of instruments in Spanish

This study investigates the argumenthood status of instruments: are instruments best classified as arguments or as adjuncts? To answer this question, we conducted two experiments, one tapping into the semantic intuitions of Spanish speakers about verbs and their participants, and the other into their syntactic intuitions. As in the English and Romanian studies, the stimuli consisted of transitives, ditransitives, and instrument verbs. Instrument verbs were further divided into verbs which *require* an

instrument and verbs which merely *allow* one. This is referred to as the allow/require distinction. We hypothesized that possible semantics/syntax mismatches along with heterogeneity within the class of instrument verbs, some allowing and some requiring an instrument, may contribute to understanding the argumenthood status of instruments.

4.4.1 Methods

Subjects

A hundred and two self-reported native speakers of Spanish (49 F, 51 M, and two unidentified) were recruited on the researchers' social media and through snowballing. I posted a description of the study and invitation in Spanish thus targeting native speakers of Spanish. To be eligible, they had to be Spanish-speaking and at least 18 years of age. The majority of the participants were temporary migrant workers in Leamington, ON, Canada. If the speakers expressed interest but did not have internet access and/or low computer literacy, I offered the alternative to do the questionnaire using pen and paper and transcribed results in excel. Incomplete answers were excluded (e.g., if speakers completed only the demographic questionnaire and not the language task). Table 4.21 provides a breakdown of the speakers by experiment and age group.

age group	Experiment	
	semantic	syntactic
18 - 22	11	17
23 - 40	35	26
40 and over	5	8

Table 4.21: Speakers' age by experiment

Design, materials and instructions

The design and materials are the same as in the English and Romanian studies and are discussed in detail in Section 4.2. For instructions and a complete list of the stimuli and their translations, see Appendix C.

4.4.2 Results

This section reports the findings from the semantic and syntactic experiments conducted with Spanish speakers. As in the English and Romanian sections, we started with an exploration of mentions of uncontroversial adjuncts to evaluate whether the two experiments elicited core and salient participants and not adjuncts. Next, we explored mentions of participants in the semantic and syntactic experiments, respectively and across verb classes (transitive/ditransitive/allow/require). Lastly, we investigated whether instrument verbs encode instruments the same way ditransitives encode an indirect object.

Adjunct production as a measure of experiment validity

Table 4.22 provides an overview of adjunct mentions in the two experiments. The proportion indicates the percentage of total responses that include an adjunct mention.

Experiment	Adjuncts (%)
semantic	1.00%
syntactic	3.10%

Table 4.22: Adjunct mentions by experiment

The low mention of adjuncts, less than 5%, indicate that the instructions were effective at teasing apart core/salient participants and adjuncts and leading speakers to mention only the former. Surprisingly, speakers produced more adjuncts in the syntactic experiment than in the semantic one, consistent with our English and Romanian findings (see Sections 4.2 and 4.3).

Overview of participants

As in the English and Romanian studies, speakers were given the subject in the syntactic experiment, but not in the semantic one. To compare across the two experiments, we only analyzed mentions of internal arguments. Consider the verb *dibujar* (*to draw*). A response such as *la muchacha, una casa, un lapiz* (*the girl, a house, a pencil*) in the semantic experiment was coded as having two participants: *una casa* (*a house*) and *un lapiz* (*a pencil*). For the remainder of the chapter, the term *participant* refers to direct objects across all verb classes, indirect objects for ditransitives, and instrument for instrument verbs.

Overall, the number of participants mentioned was similar across the two experiments (semantic: $M = 1.28$, $SD = 0.52$; syntactic: $M = 1.03$, $SD = 0.20$) with a greater variability in the semantic experiment, as indicated by the standard deviation. Figure 4.11 illustrates the overall pattern of participant mentions.

Figure 4.11: Participants by experiment and verb class

Figure 4.11 shows the median, mean, and variability of the data. It reveals the following overall generalizations: within the semantic experiment, *require*-instrument verbs had a higher median (med = 2) than *transitives*, *ditransitives*, and *allow*-instrument verbs (med = 1). In terms of mean (*) and data distribution, *ditransitives* and *require*-instrument verbs patterned together with values higher than *transitives* and *allow*-instrument verbs. In the syntactic experiment, all four verb classes patterned together on all measures.

We used linear mixed-effects regression models (lmer) in R to further explore the relationship between the number of participants, experiment, and class. Class (transitive, ditransitive, allow, require) and experiment (semantic, syntactic) were included as fixed effects. Speaker was included as a random effect. The number of participants was the dependent variable.

The analysis revealed a main effect of class ($\chi^2 = 764.01$, $p < .001$), a main effect of experiment ($\chi^2 = 83.41$, $p < .001$), and a class*experiment interaction ($\chi^2 = 534.04$, $p < .001$). We followed up on the interaction by examining the simple effects for each verb class. Of interest were the transitive/ditransitive and the allow/require comparisons, respectively. Transitive and ditransitive verbs differed significantly with ditransitives eliciting more participants than transitives in both experiments (semantic, $z = 26.79$, $p \leq .0001$; syntactic, $z = 7.69$, $p \leq .0001$). *Allow* and *require* verbs differed significantly in the semantic experiment with *require* verbs eliciting more participants than *allow* verbs ($z = 17.30$, $p \leq .0001$). There were no significant differences in the syntactic experiment ($z = 0.27$, $p = 1.00$). Figure 4.12 illustrates the class*experiment interaction:

Figure 4.12: Class*experiment interactions for the number of participants

Figure 4.12 illustrates that speakers' responses differ across verb classes and experiments. Next, we further explored these details by comparing speakers' responses in

the transitive/ditransitive verb classes, and in the allow/require respectively.

Transitive/Ditransitive verbs

The number of participants

We predict that ditransitive verbs such as *dar/give* would elicit more participants than transitive verbs such as *abrazar/hug*. Since not all participants are obligatory in the linguistic string, there may be less participant mentions in the syntactic experiment than in the semantic one, particularly for ditransitive verbs. Table 4.23 provides a descriptive summary of participants by verb class in the two experiments.

	Semantic		Syntactic	
Class	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
transitive	0.97 (0.35)	1	0.99 (0.13)	1
ditransitive	1.40 (0.54)	1	1.11 (0.32)	1

Table 4.23: Number of participants by experiment and by verb class

Table 4.23 shows that ditransitive verbs elicited more participant mentions than transitive verbs in both experiments, as predicted. Table 4.24 illustrates participant mentions in transitive verbs.

	Participants (%)
Experiment	do
semantic	89.18%
syntactic	97.93%

Table 4.24: Mentions of participants by experiment in transitive verbs

Table 4.24 shows that most transitive verbs elicited a participant corresponding to the direct object, with more mentions in the syntactic experiment than in the semantic one.⁴

⁴Speakers treated some transitive verbs (less than 3%) as ditransitives. All but one io/goal men-

Table 4.25 illustrates participant mentions in ditransitive verbs.

Experiment	Participants (%)		
	do	io	do and io
semantic	74.87%	65.11%	38.66
syntactic	82.06%	31.39%	13.56

Table 4.25: Mentions of participants by experiment in ditransitive verbs

Table 4.25 shows that the majority of ditransitives (74% to 83%) elicited a participant corresponding to the direct object in both experiments. The indirect object was mentioned in approximately 65% of the responses in the semantic experiment, but only in 31% in the syntactic one highlighting the semantics/syntax mismatch discussed in Section 1.2, Chapter 1.

Allow/Require verbs and the status of instruments

We asked whether the allow/require distinction holds in Spanish. And if so, whether it may contribute to explaining the uncontroversial status of instruments.

The number of linguistic participants

Table 4.26 provides a descriptive summary of the participants produced by experiment (semantic/syntactic) and class (allow/require).

Class	Semantic		Syntactic	
	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
allow	1.23 (0.44)	1	1.00 (0.14)	1
require	1.50 (0.58)	1	1.00 (0.10)	1

Table 4.26: Number of participants by verb class and experiment

tions were associated with *decir/say* as in *hombre/mujer/mentira* (*man/woman/lie*). The results suggest that for some speakers, there is no difference between *to say/decir* and *to tell/contar*. This finding resonated with the English and Romanian results (Sections 4.2-4.3).

Verbs in the *allow* and *require* classes elicited more mentions in semantic experiment than in the syntactic one. Within the semantic one, *require* verbs elicited more participant mentions than *allow* verbs.

The types of participants

We asked whether speakers may perceive instruments differently when encountering a *require*-instrument verb than when encountering an *allow*-instrument verb. Since all instrument verbs included in this study are transitive, we expect direct object (do) mentions in nearly all responses regardless of verb class. Thus, direct objects can serve as a control. If the direct object is mentioned for most verbs, it suggests that the experiment was successful at eliciting core participants. From there, we can assume that any differences in instrument mentions relative to direct object mentions may provide insights into whether speakers perceive instruments and direct objects alike. Table 4.27 illustrates direct object (do) and instrument mentions in *allow*- and *require*-instrument verbs in both experiments.

		Participants	
	Experiment	do	instrument
allow	semantic	95.85%	24.40%
	syntactic	98.65%	0.94%
require	semantic	78.42%	70.95%
	syntactic	99.06%	0.62%

Table 4.27: Mentions of participants by experiment in allow and require verbs

The direct object was mentioned by the majority of the speakers in both the semantic and the syntactic experiment, for both *require*- and *allow*-instrument verbs. This provides support for the claim that the instructions were successful at eliciting mentions of core participants.

Instruments were mentioned in the semantic experiment whereas in the syntactic one, they were virtually negligible, consistent with previous studies on English data (Barbu, 2015; Barbu and Toivonen, 2016b,a) and the English and Romanian findings presented above in Chapters 4.2 and 4.3. Within the semantic experiment, instrument mentions were comparable to direct object mentions for *require*-instrument verbs and considerably lower for *allow*-instrument verbs. Though these findings do not clarify the status of instruments as arguments or adjuncts, they provide evidence that whatever the status of instruments may be, it is different than that of clear arguments and clear adjuncts. On one hand, clear adjuncts are unmentioned in both experiments as we saw earlier, whereas instruments are prevalent in the semantic one. On the other hand, clear arguments such as direct objects are prevalent in both experiments, not just in the semantic one.

Further analyses were conducted for the mentions of instruments, experiment, and class using mixed-effects logistic regression models in R. Class and experiment were included as fixed effects and speaker as a random effect. The mentions of instruments (categorical; yes/no) was the dependent variable.

For mentions of instruments, there was a main effect of experiment ($\chi^2 = 156.37$, $p \leq .001$) with instruments being more prevalent in the semantic one than in the syntactic one. There was also a main effect of class ($\chi^2 = 88.73$, $p \leq .001$), with *require*-instrument verbs eliciting more instrument mentions than *allow*-instrument verbs; and a class*experiment interaction ($\chi^2 = 66.76$, $p \leq .001$) such that *require*-instrument verbs elicited more instruments than *allow*-instrument verbs in the semantic experiment ($z = 20.38$, $p \leq .0001$), whereas in the syntactic one there were no differences ($z = -0.78$, $p = 0.99$).

Figure 4.13 provides a visualization of the relations described above, illustrating the mean rates of choosing an instrument by experiment and verb class.

Figure 4.13: Mean rates of choosing instruments by experiment and class

Figures 4.14 and 4.15 illustrate the percentage of the speakers who mentioned an instrument for a given verb in the semantic and syntactic experiment, respectively.

Figure 4.14: Allow/require instruments in the semantic experiment

Figure 4.15: Allow/require instruments in the syntactic experiment

Figures 4.14 and 4.15 provide support for the allow/require distinction. Similar to the English and Romanian findings reported in Chapters 4.2 and 4.3, the distinction is once again gradual, not categorical. A handful of verbs do not pattern within their predicted category. The verbs *touch*, *hit*, *defeat*, and *vaccinate* were classified as *require* verbs and patterned with *allow*. Interestingly, the verbs *touch* and *hit* patterned against our expectations in English, Romanian, and Spanish. One characteristic these two verbs have in common is that the instrument could be a body part. Similar to the English and Romanian findings, there were negligible instrument mentions in the syntactic experiment.

Comparing instruments and indirect objects

So far we've determined that instruments behave differently than direct objects. This section compares mentions of instruments for allow/require verbs and indirect objects for ditransitive verbs. Tables 4.28-4.29 show the percentages of instrument mentions for allow/require verbs and indirect object mentions for ditransitive verbs.

	verb class	%
instruments	allow	0.94
	require	0.62
indirect objects	ditransitive	31.39

Table 4.28: Mentions of instruments in require/allow and indirect objects in ditransitives in the syntactic experiment

	verb class	%
instruments	allow	24.40
	require	70.95
indirect objects	ditransitive	65.11

Table 4.29: Mentions of instruments in require/allow and indirect objects in ditransitives in the semantic experiment

Tables 4.28 and 4.29 show that *required* instruments but not *allowed* ones pattern closely with indirect objects in the semantic experiment. In the syntactic one however, (some) indirect objects are still mentioned whereas instruments are not. In sum, instruments are similar to indirect objects only at the conceptual level, and in particular for *require*-instrument verbs.

4.4.3 Interim summary

Speakers' responses revealed a low production of adjuncts and a high production of direct objects in both experiments in all four verb classes. These findings provide support for the claim that the instructions teased apart core/salient and peripheral participants, eliciting mentions of the former only, as we intended. Instruments were prevalent in the semantic experiment but virtually nonexistent in the syntactic one (less than 1% mentions). Within the semantic experiment, *require*-instrument verbs elicited significantly higher mentions of instruments than *allow*-instrument verbs, consistent with the English and Romanian findings reported in Sections 4.2 and 4.3 above.

4.5 The status of instruments in Turkish

This study is the first to explore the status of instruments as arguments or adjuncts in Turkish. To this end, we conducted two experiments: one assessing the status of instruments at the semantic level, and the other at the syntactic level. Furthermore, we asked whether instrument verbs form a unified class or they can be further classified into *require*-instrument and *allow*-instrument verbs. *Allow*-instrument verbs merely

allow the presence of an instrument whereas *require*-instrument ones necessitate an instrument. This is known as the allow/require distinction. Similar to the studies discussed in Sections 4.2-4.4, the stimuli consisted of transitive, ditransitive, *require*-instrument, and *allow*-instrument verbs.

4.5.1 Methods

Subjects

A hundred and five self-reported native speakers of Turkish (90 F, 15 M) were recruited on the researchers' social media and through snowballing. The Turkish experiment was done in close collaboration with Lara Russo, a fourth year Linguistics student at the time, and herself a native speaker of Turkish. Lara posted a description of the study and invitation to the study in Turkish, thus targeting Turkish speakers. To be eligible, speakers had to be Turkish-speaking and at least 18 years of age. Incomplete answers were excluded; for example, if speakers completed only the demographic questionnaire and not the language task. Table 4.30 provides a breakdown of the speakers by experiment and age group.

age group	Experiment	
	semantic	syntactic
18 - 22	1	0
23 - 40	23	15
40 and over	31	35

Table 4.30: Speakers' age by experiment

Design, materials and instructions

The design and materials are the same as in the English, Romanian, and Spanish study and are discussed in detail in Chapter 4.2. For instructions, a complete list of the stimuli and their translations, see Appendix D.

4.5.2 Results

This section provides an overview of uncontroversial adjunct production in the semantic and the syntactic experiments, as well as mentions of participants by experiment and verb class (transitive/ditransitive/allow/require). Lastly, it investigates whether speakers perceive instruments and indirect objects the same.

Adjunct production as a measure of experiment validity

Table 4.31 shows the proportion of responses mentioning an uncontroversial adjunct in the semantic and the syntactic experiment, respectively.

Experiment	Adjuncts (%)
semantic	5.7%
syntactic	10.80%

Table 4.31: Adjunct mentions by experiment

The aim was to elicit mentions of core/salient participants and not of uncontroversial adjuncts. The results suggest that the experimental instructions were effective with less than 11% adjunct mentions per experiment. Consistent with the English, Romanian, and Spanish findings reported in Sections 4.2-4.4, speakers produced more adjuncts in the syntactic experiment than in the semantic one. Interestingly, Turkish had the highest proportion of adjunct mentions out of the four languages. This

was particularly obvious in the syntactic experiment, where in Turkish 10.80% of the responses included an adjunct, whereas in the other three languages less than 6% included an adjunct. This can perhaps be explained by the fact that Turkish allows argument-drop quite freely, which may have led speakers to include necessary information based on principles other than syntactic obligatoriness.

Overview of participants

Details on how speaker responses were coded are discussed in Section 4.2. The number of participants mentioned was similar across the two experiments (semantic: $M = 1.13$, $SD = 0.58$; syntactic: $M = 1.06$, $SD = 0.31$), with a greater variability in the semantic one. Figure 4.16 illustrates the overall pattern of participant mentions. The star indicates the mean, the vertical line indicates the median, and individual dots indicate outliers.

Figure 4.16: Participants by experiment and verb class

Figure 4.16 reveals that all four verb classes, *transitives*, *ditransitives*, *allow-* and *require-*instrument verbs had the same median ($\text{med} = 1$) in both the semantic and the syntactic experiments. Within the semantic experiment, *require-*instrument verbs had the highest mean and largest data distribution. In the syntactic experiment, all four verb classes patterned together.

Further analyses were conducted to explore the relationship between the number of participants, experiment, and class using linear mixed-effects regression models (lmer) in R. Class (transitive, ditransitive, allow, require) and experiment (semantic, syntactic) were included as fixed effects. Speaker was included as a random effect. The number of participants was the dependent variable.

The analysis revealed a main effect of class ($\chi^2 = 531.42$, $p < .001$), and a class*experiment interaction ($\chi^2 = 381.26$, $p < .001$). We followed up on the interaction by examining the simple effects for each verb class. Of interest are the transitive/ditransitive and the allow/require comparisons, respectively. Transitive and ditransitive verbs differed significantly with ditransitives eliciting more participants than transitives in both experiments (semantic, $z = 16.45$, $p < .0001$; syntactic, $z = 7.28$, $p < .0001$). *Require-* and *allow-*instrument verbs differed significantly with *require* eliciting more participants than *allow-*instrument verbs ($z = 12.48$, $p < .0001$). There were no significant differences in the syntactic experiment ($z = 1.04$, $p = 0.97$). Figure 4.17 illustrates the class*experiment interaction:

Figure 4.17: Class*experiment interactions for the number of participants

Figure 4.17 shows that speakers' responses differ across verb classes and experiments except for ditransitive verbs, which seem to pattern together in the two experiments. Next, we analyzed the speakers' responses in the transitive/ditransitive verb classes, and in the allow/require respectively.

Transitive/Ditransitive verbs

The number of participants

Turkish is particularly interesting when it comes to participant mentions because it is a subject and object pro-drop language. In other words, very little is obligatory in the linguistic string. In English, Spanish and Romanian, we predicted that ditransitive verbs such as *give* will elicit more participants than transitive verbs such as *hug* in both experiments. In Turkish however, we expect less of a difference in participant mentions between transitive and ditransitive verbs in the syntactic experiment. This

is due to the fact that the direct and indirect objects are not obligatory in the linguistic string. Overall, we expect less participant mentions in the syntactic experiment in Turkish compared to the other three languages. Table 4.32 provides a descriptive summary of participants by class in the semantic and the syntactic experiment, respectively.

	Semantic		Syntactic	
Class	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
transitive	0.85 (0.46)	1	1.01 (0.17)	1
ditransitive	1.14 (0.57)	1	1.14 (0.41)	1

Table 4.32: Number of participants by experiment and by verb class

Table 4.32 shows that ditransitive verbs elicited more participant mentions than transitive verbs in both experiments. Interestingly, responses for both transitive and ditransitive verbs were comparable with English, Spanish, and Romanian in the syntactic experiment despite our prediction that there will be fewer mentions. On the contrary, in the semantic experiment, the number of participant mentions for transitive and ditransitive was the lowest out of the four languages. Table 4.33 illustrates participant mentions in transitive verbs.

	Participants (%)
Experiment	do
semantic	79.40
syntactic	92.83

Table 4.33: Mentions of participants by experiment in transitive verbs

Table 4.33 shows that most transitive verbs elicited a participant corresponding to the direct object with the trend being more prominent in the syntactic experiment than in the semantic one.⁵ Table 4.34 illustrates participant mentions in ditransitive

⁵As in Romanian, Spanish, and English, Turkish speakers also treated some transitive verbs (less than 2%) as ditransitive. The io/goal mentions were traced back to the verbs *say*, *pull*, *spill*, and *grab*.

verbs.

Participants (%)			
Experiment	do	io	do and io
semantic	75.19	38.90	24.23
syntactic	82.84	31.68	16.84

Table 4.34: Mentions of participants by experiment in ditransitive verbs

Table 4.34 illustrates that the majority of ditransitive verbs (75% to 83%) elicited a participant corresponding to the direct object. On the other hand, the indirect object was mentioned in approximately 38.90% of the responses in the semantic experiment and in 32% in the syntactic one. Interestingly, Turkish had the lowest io mentions in the semantic experiment; in Spanish, Romanian, and English, indirect objects were mentioned in more than 50% of the responses.

Allow/Require verbs and the status of instruments

The number of linguistic participants

Table 4.35 provides a descriptive summary of the participants produced by experiment (semantic/syntactic) and class (allow/require).

Class	Semantic		Syntactic	
	mean (<i>SD</i>)	median	mean (<i>SD</i>)	median
allow	1.16 (<i>0.56</i>)	1	1.03 (<i>0.24</i>)	1
require	1.38 (<i>0.60</i>)	1	1.06 (<i>0.24</i>)	1

Table 4.35: Number of participants by verb class and experiment

Instrument verbs elicited more participant mentions in the semantic experiment than the syntactic one. Within the semantic experiment, *require*-instrument verbs elicited more participant mentions than *allow*-instrument verbs. These findings resonate across the four languages.

The types of participants

This section compares mentions of direct objects and instruments by experiment and across *allow* and *require* verbs. Table 4.36 illustrates the proportion of responses including direct objects (do) and instruments in *allow*- and *require* instrument verbs.

		Participants	
	Experiment	do	instrument
allow	semantic	77.77%	29.41%
	syntactic	95.22%	0.67%
require	semantic	72.99%	52.65%
	syntactic	95.20%	3.40%

Table 4.36: Mentions of participants by experiment in allow and require verbs

Table 4.36 illustrates that most speakers mentioned a direct object in both experiments, with more mentions in the semantic than the syntactic one. This suggests that our instructions were successful at eliciting mentions of core participants.

Consistent with findings presented above in Chapters 4.2, 4.3, and 4.4, instruments were elicited in the semantic experiment by some speakers and virtually unmentioned in the syntactic one. Within the semantic experiment, the results are consistent with the English, Romanian, and Spanish findings (see Chapters 4.2-4.4) such that *require*-instrument verbs elicited more instrument mentions than *allow*-instrument verbs.

Further analyses were conducted for the mentions of instruments, experiment, and class using mixed-effects logistic regression models in R. Class and experiment were included as fixed effects; speaker as a random effect. The mentions of instruments (categorical; yes/no) was the dependent variable.

For mentions of instruments, there was a main effect of experiment ($\chi^2 = 121.34$, $p < .001$) with instruments being more prevalent in the semantic one than in the

syntactic one. There was also a main effect of class ($\chi^2 = 135.82$, $p < .001$), with *require*-instrument verbs eliciting more instrument mentions than *allow*-instrument verbs. There was no class*experiment interaction. Figure 4.18 provides a visualization of the relations described above, illustrating the mean rates of choosing an instrument by experiment and verb class.

Figure 4.18: Mean rates of choosing instruments by experiment and class

Figures 4.19 and 4.20 illustrate the percentage of the speakers who mentioned an instrument for *require*-instrument verbs and *allow*-instrument verbs in the semantic and syntactic experiment, respectively.

Figure 4.19: Allow/require instruments in the semantic experiment

Figure 4.20: Allow/require instruments in the syntactic experiment

Figures 4.19 and 4.20 provide some support for the allow/require distinction though the distinction is gradual rather than categorical. These results are consistent with the English, Spanish, and Romanian findings reported in Sections 4.2-4.4. A handful of verbs did not pattern within their predicted category. In the semantic experiment, the verbs *clean* and *wash* were classified as *allow*-instrument but patterned with *require*-instrument verbs. The verbs *hit*, *dissect*, *touch*, *scratch*, and *beat* were classified as *require* verbs and patterned with *allow*. We see once again that the majority of the *require*-instrument verbs that patterned with *allow* could be carried out using a body part. Similar to the findings reported in Sections 4.2-4.4, there were negligible instrument mentions in the syntactic experiment.

Comparing instruments and indirect objects

This section compares mentions of instruments for allow/require verbs and indirect objects for ditransitive verbs.

	verb class	%
instruments	allow	0.67
	require	3.40
indirect objects	ditransitive	31.68

Table 4.37: Mentions of instruments in require/allow and indirect objects in ditransitives in the syntactic experiment

	verb class	%
instruments	allow	29.41
	require	52.65
indirect objects	ditransitive	38.90

Table 4.38: Mentions of instruments in require/allow and indirect objects in ditransitives in the semantic experiment

Tables 4.37 and 4.38 show that while indirect objects are close to equally mentioned in

the syntactic and the semantic experiments, *required* instruments are only mentioned in the semantic one. Interestingly, instruments are more prominent than indirect objects in the semantic experiment.

4.5.3 Interim summary

Findings revealed that speakers mentioned direct objects in both experiments across all verb classes whereas mentions of adjuncts were negligible. Thus, the instructions were successful at teasing apart core/salient and peripheral participants and at eliciting core/salient participants only. Once again, instruments were prevalent in the semantic experiment and negligible in the syntactic one (less than 11% mentions). Within the semantic experiment, *require*-instrument verbs elicited significantly higher mentions of instruments than *allow*-instrument verbs providing support for the allow/require distinction.

4.6 General cross-linguistic analysis

The present study is a cross-linguistic investigation of the status of instruments as arguments or adjuncts. Part of this study, we assessed instruments from both a semantic and a syntactic perspective. Additionally, we explored whether the allow/require distinction may help explain their controversial status. The detailed research questions were presented in Section 4.1.

We started with 76 instrument verbs equally divided across *transitives*, *ditransitives*, and *instrument*-verbs. *Instrument*-verbs were further divided into *allow*- and *require*-instrument verbs following Koenig et al.'s (2008) and Rissman's (2013) clas-

sification. These verbs served as stimuli for two experiments, one capturing speakers' semantic intuitions about verbs and their participants, and one their syntactic intuitions. These two experiments were conducted in four languages, English, Romanian, Spanish, and Turkish to investigate the status of instruments cross-linguistically.

4.6.1 The validity of the experimental set-up

Earlier, I illustrated the argument/adjunct distinction with example (1) repeated here and described it as clear and intuitive:

(78) Aura gave a yellow dress to Mary last summer at the beach.

An event can involve many participants; however, these participants differ in their status. The experiments reported in this chapter were conducted under the assumption that speakers distinguish between core (Aura, a yellow dress, Mary) and peripheral participants (last summer, and at the beach). The instructions aimed to tease apart between the two and lead speakers to mention core and salient participants alone.

I evaluated mentions of uncontroversial adjuncts such as time, place, and manner in the semantic and syntactic experiments. Adjuncts were mentioned in less than 6% of all responses in the semantic experiment and in less than 11% in the syntactic one. Spanish had the lowest number of adjunct mentions (semantic 1.00%, syntactic 3.10%) whereas Turkish had the highest (semantic 5.70%, syntactic 10.80%). Romanian and English fell in-between (Romanian: semantic 3.30%, syntactic 5.10%; English: semantic 3.53%, syntactic 5.84%).

The low prevalence of uncontroversial adjuncts suggests that the instructions were successful at leading speakers not to mention adjuncts. However, to claim that the

instructions successfully teased apart core and peripheral participants, we must show not only that speakers did not mention adjuncts, but that they did mention arguments. To assess this, I looked at the production of direct objects.⁶ Table 4.39 below reviews direct object mentions by language and experiment:

	English	Romanian	Spanish	Turkish
sem	98.73%	91.43%	89.18%	76.06%
syn	100%	98.70%	97.93%	91.68%

Table 4.39: Direct Object Mentions by Language and Experiment

Table 4.39 shows that the direct object was mentioned in over 75% of the responses in the semantic experiment and in over 90% in the syntactic one across languages. Turkish had the lowest mentions, followed by Spanish, Romanian, and English. Overall, the results suggest that the instructions successfully elicited the direct object with some variation across languages.

Though overall the instructions were successful at eliciting core participants, there are a few observations worth pointing out. Firstly, Turkish elicited the lowest mentions of direct objects amongst the four languages in both experiments. We predicted Turkish will have the lowest mentions of direct objects in the syntactic experiment because it allows object pro-drop (Türker, 2019, p. 58); however, we expected no differences in direct object mentions in the semantic one. These findings suggests that the freer syntactic optionality in Turkish may influence the speakers' conceptual perception of an event.

In sum, the lack of uncontroversial adjunct mentions along with the high rates of direct object mentions suggest that the instructions successfully teased apart speakers' intuitions between core/salient and peripheral participants and elicited only the

⁶We are looking at direct objects alone because direct object are more often than not obligatory in the linguistic string whereas indirect objects are sometimes optional.

former.

4.6.2 On ditransitivity

Though ditransitivity is not a main focus of this thesis, the studies conducted provide the opportunity to explore the prevalence of ditransitive verbs cross-linguistically. Intuitively, verbs such as *give* take three participants: the giver, the object, and the receiver. The data collected reveals whether speakers mention three participants for the 19 potentially ditransitive verbs included in the study.⁷

Table 4.40 below shows the proportion of responses that included both the do and the io averaged across ditransitive verbs and speakers:

	English	Romanian	Spanish	Turkish
sem	35.18%	35.21%	38.66%	24.23%
syn	29.65%	12.96%	13.56%	16.84%

Table 4.40: Proportions of direct and indirect objects by language and experiment

Table 4.40 shows that less than 50% of the responses included both the do and io with the % being lower in the syntactic experiment. This suggests that the ditransitive verbs included in this study were not perceived as ditransitive by the majority of speakers in the semantic and syntactic experiments.⁸ This proportion is however averaged across speakers and verbs. It does not reveal whether only some speakers mentioned both internal arguments, whether only some verbs elicited both internal

⁷Languages have far fewer ditransitive verbs than transitive verbs, and some languages such as !Xun don't have any ditransitive verbs (Malchukov et al., 2010, p. 2,77). Others go as far as to claim that ditransitivity is not real (Cuervo, 2010). However, such claims are often at the syntactic rather than conceptual level.

⁸One could think that the low mentions of direct and indirect objects may be a result of the methodology. However, the fact that mentions of direct objects were high across the four verb classes in both experiments suggest that the experimental set up was reliable at eliciting mentions of arguments.

arguments, or a combination of the two. Tables 4.41-4.42 aim to elucidate that.

Table 4.41 illustrates which verbs were interpreted as ditransitive by at least one speaker. A check-mark (✓) indicates that at least one speaker mentioned both the do and the io for a given verb whereas an x-mark (✗) indicates that no speakers mentioned both.

	English		Spanish		Romanian		Turkish	
verb	sem	syn	sem	syn	sem	syn	sem	syn
advise	✓	✓	✓	✓	✓	✓	✓	✓
ask	✓	✓	✓	✓	✓	✓	✓	✓
bring	✓	✓	✓	✓	✓	✓	✓	✓
buy	✓	✗	✓	✗	✓	✗	✓	✓
deliver	✓	✓	✓	✓	✓	✓	✓	✓
encourage	✓	✓	✓	✓	✓	✓	✓	✓
feed	✓	✓	✓	✓	✓	✗	✓	✓
force	✓	✓	✓	✓	✓	✗	✓	✓
give	✓	✓	✓	✓	✓	✓	✓	✓
lend	✓	✓	✓	✓	✓	✓	✓	✓
persuade	✓	✓	✓	✓	✓	✓	✓	✓
pour	✓	✓	✓	✓	✓	✓	✓	✓
promise	✓	✓	✓	✓	✓	✓	✓	✓
recommend	✓	✓	✓	✗	✓	✓	✓	✓
sell	✓	✓	✓	✗	✓	✓	✓	✓
send	✓	✓	✓	✓	✓	✓	✓	✓
show	✓	✓	✓	✓	✓	✓	✓	✓
tell	✓	✓	✓	✓	✓	✓	✓	✓
throw	✓	✓	✓	✓	✓	✓	✓	✓

Table 4.41: Mentions of Direct and Indirect Objects

In the semantic experiment, all verbs were interpreted as ditransitive by at least one speaker. In the syntactic one, there are five verbs for which no speaker listed both the direct and indirect object: *buy* in English, Spanish, and Romanian, *feed* and *force* in Romanian, *recommend* and *sell* in Spanish.

Table 4.42 illustrates the proportion of speakers who mentioned both the do and io.

I am illustrating the verbs for which 50% or more speakers mentioned both the do and the io. The missing values indicate that less than 50% of the speakers mentioned both internal arguments. For a complete list of speaker proportions by verb, experiment, and language, see Table 7 in Appendix E.

verb	English		Spanish		Romanian		Turkish	
	sem	syn	sem	syn	sem	syn	sem	syn
lend	≥ 50	≥ 50	≥ 50		≥ 50			
force		≥ 50	≥ 50	≥ 50				
give		≥ 50	≥ 50		≥ 50			
pour			≥ 50		≥ 50			
feed	≥ 50				≥ 50			
promise			≥ 50					
recommend			≥ 50					
sell					≥ 50			
buy					≥ 50			
show					≥ 50			
send			≥ 50					
tell								
throw								
advise								
ask								
bring								
deliver								
encourage								
persuade								

Table 4.42: Mentions of direct and indirect objects proportions

Table 4.42 shows that only a handful of verbs were perceived as ditransitive by more than 50% of the speakers. The verbs *lend*, *force* and *give* were perceived as ditransitive in English, Spanish, and Romanian whereas the other verbs showed inter-language variation. Interestingly, Turkish was the only language for which none of the verbs were perceived as ditransitive by more than 50% of the speakers. Given the high degree of optionality in Turkish, we expected low participant mentions in the syntactic

experiment. In the semantic one however, we expected no differences across the four languages. As already suggested above, the Turkish findings could indicate that the freedom at the syntactic level may influence the speakers' conceptualization of the event.

In sum, Tables 4.40, 4.41, and 4.42 show that there is variation across ditransitive verbs, consistent with Rissman et al.'s (2015) findings. This variation and the low rates of direct and indirect object mentions call into question current classifications of ditransitive verbs and suggest that perhaps only a handful of verbs are true ditransitives.

4.6.3 The syntactic status of instruments

Speakers were presented with the beginning of a sentence: the subject and the verb. They were asked to complete the sentence with the minimal amount of information necessary. The intention was to elicit arguments only. The majority of the speakers completed the sentence with a direct object with no or few mentions of uncontroversial adjuncts suggesting we were successful at eliciting syntactic arguments alone.

We asked what the status of instruments is from a syntactic perspective. The present study found that syntactically, instruments were virtually non-existing. This finding held true across the four languages, and it was consistent with the English findings reported in Barbu (2015); Barbu and Toivonen (2016a,b) who employed a similar methodology. The authors found 0% instrument mentions in the syntactic experiment (except the verb *draw*, for which 5% of the speakers mentioned an instrument). They concluded that though instruments are conceptualized as event participants and potential semantic arguments, syntactically they behave as adjuncts.

Sedivy and Spivey-Knowlton (1994) reached to a similar conclusion based on syntactic diagnostic tests. The optionality, VP anaphora, ordering, and insertion of subject-oriented emphatic reflexives tests identified instruments as adjuncts.

In contrast, in a reading experiment Schütze (1995) found that *with*-instruments phrases were read faster than uncontroversial *with*-modifiers, suggesting instruments have a privileged status compared to uncontroversial adjuncts. Similarly, in a sentence continuation task, Koenig et al. (2002) reported that when presented with an instrument verb, speakers produced significantly more instruments than uncontroversial adjuncts (e.g., time, place, manner, reason). Though the instructions were almost identical, Koenig et al. (2002) reported significantly higher instrument mentions in a sentence completion task than the present study. There is however a key difference between Koenig et al.'s stimuli and the present one. Compare (79-a) and (79-b):

- (79) a. Dana ate the bowl of soup ...
 b. Dana ate ...

Example (79-a) illustrates a stimuli sentence in Koenig et al.'s study, whereas (79-b) illustrates a stimuli sentence in the present study. The difference is that Koenig and colleagues provided the speakers with the direct object whereas the present study did not. Koenig and colleagues asked speakers to provide a continuation to sentences where no syntactic information was missing. In other words, they lead the speakers to express syntactically optional phrases. In the present study however the stimuli aimed to elicit only syntactically necessary information (i.e., the direct object), with no need to express syntactically optional phrases.

On our interpretation, the experimental data presented here indicates that syntactically instruments behave as adjuncts cross-linguistically. This conclusion is sup-

ported by the syntactic diagnostic tests presented in Chapter 3. The fact that instruments are prevalent in the semantic experiment, as we review shortly, but syntactically optional, may be a contributing factor as to why instruments seem to have an ‘in-between’ arguments and adjuncts status.

4.6.4 The semantic status of instruments

Speakers were presented with a verb and asked to imagine the situation described by the verb. Their task was to state the participants necessary for the event to occur. The intention was to elicit core participants but not peripheral ones. The majority of the speakers did mention core participants, specifically the participant corresponding to the direct object. Similar to the syntactic experiment, mentions of peripheral participants were negligible suggesting we were successful at eliciting core participants and not peripheral.

We asked what the status of instruments is from a semantic perspective. Compared to the syntactic study, speakers did mention instruments along with traditional core participants suggesting that instruments have a privileged status compared to peripheral participants. Mentions of instruments were however not as prevalent as direct objects, with variation across verbs. Next we asked whether this variation may be due to the fact that instrument verbs do not form a unified class but are divided into verbs that require an instrument and verbs that merely allow an instrument. In other words, we asked whether speakers were more likely to mention an instrument for *require*-instrument verbs than for *allow*-instrument verbs. Findings showed that *require*-instrument verbs elicited significantly more instrument mentions than *allow*-instrument verbs. However, this distinction was gradual not categorical. These

findings were consistent across the four languages.

Despite the open-ended nature of the semantic experiment along with differences between speakers and languages, only five verbs initially classified as *allow*-instrument verbs patterned with *require*-instrument verbs, four vice versa, and two verbs had inconsistent response patterns across languages. Next, we explored why these verbs patterned differently than predicted.

***Require*-instrument verbs that patterned as *allow*-instrument verbs**

The four verbs that were initially classified as *require*-instrument verbs but patterned as *allow*-instrument verbs based on the speakers' responses are: *hit*, *touch*, *beat*, and *scratch*.

touch: Less than 30% of the speakers mentioned an instrument in each of the four languages. Rissman (2013) classified the verb *touch* as requiring an instrument based on its semantic similarity to the verbs *beat* and *hit*, which were previously classified as requiring an instrument in Koenig et al. (2008). While I agree with Rissman (2013)'s judgement that touching does require an instrument, verbs such as *touch* differ from other *require*-instrument verbs. Consider the verb *slice*. While slicing requires an external instrument such as a knife, touching most likely relies on a body part as an instrument. It may be the case that external instruments and body part instruments are perceived differently by the speakers. This may explain why though *touch* requires an instrument, it only elicited a few instrument mentions.

hit: The verb *hit* was treated as allowing an instrument by 50% of the English speakers and by less than 50% of the Romanian, Spanish, and Turkish speakers,

respectively. Koenig et al. (2008) classified the verb *hit* as requiring an instrument such that someone would be hitting a person with something. Across languages, speakers' responses fell broadly in two categories: responses which include an explicit mention of an instrument such as *a baseball bat* in *a person*, *a baseball bat*, *a ball*, and responses with no instrument mentions such as *two people*. Perhaps in the case of responses with no explicit instrument, the speakers had in mind a body part instrument.

beat: The verb *beat* was treated as allowing an instrument by 35 to 45% of the English, Romanian, and Turkish speakers and by only 12.5% of the Spanish speakers. Koenig et al. (2008) classified the verb *beat* as requiring an instrument such that someone would be beating a person with something. The Spanish responses patterned differently due to a difference in meaning. The Spanish translation of *beat*, *vencer* does not have the meaning of beating someone with something, but beating someone at something. This elicited answers such as *un ganador y un perdedor/a winner and a loser*. The Spanish translation of the verb *beat* was poorly chosen as I realized the difference in meaning post-hoc. This emphasizes the obvious observation that it is important to pay careful attention to the lexical semantics of individual words when conducting cross-linguistics comparisons.

Moreover, in English, Romanian, Turkish, the verb *beat* elicited similar responses as the verb *hit* above. Responses fell in two categories: explicit mention of an instrument such as *tamplar*, *cuie*, *ciocan/a carpenter*, *nail*, *a hammer*, and no instrument mentions such as *o persoana*, *o alta persoana/a person*, *another person*. Once again, it may be the case that when no instrument was mentioned, the speakers had in mind a body part instrument.⁹

⁹At least in English and Romanian, speakers could have also interpreted the verb 'to beat' as 'to

scratch: The verb *scratch* was treated as allowing an instrument by 50% of the Romanian speakers, by 37.5% or less of the English and Turkish speakers, and by 75% of the Spanish speakers. The fact that Spanish responses patterned differently is due to a difference in meaning. The Spanish translation of *scratch*, *rayar* means both *scratch* and *underline*. The speakers' responses were divided across the two meanings with the latter being a majority. While scratching is most often associated with a body part instrument such as nails, underlining takes an external instrument such as a pencil. This explains the higher instrument mentions in Spanish. Aside from the meaning ambiguity in Spanish, responses overall were divided into explicit mentions of an instrument such as *lottery ticket and coin*, and no instrument mentions such as *a dog and ear*. Once again, body-part instruments are not explicitly mentioned.

In sum, the four verbs above suggest that speakers may perceive body part instruments differently than external instruments. Specifically, while external instruments are often explicitly stated, instrument body parts may be implicit. Thus, we eliminated the verbs *touch*, *hit*, *beat*, and *scratch* from the upcoming cross-linguistic overview of the allow/require distinction.

Allow-instrument verbs that patterned as require-instrument verbs

The five verbs that were initially classified as *allow-instrument* verbs but patterned as *require-instrument* verbs based on the speakers' responses are: *clean*, *calculate*, *wash*, and *kill*.

clean: The verb *clean* was treated as requiring an instrument by over 50% of win over', however, there was no clear indication of that.

the speakers in all four languages. Rissman (2013)'s justification for classifying the verb *clean* as merely allowing an instrument verb was that cleaning is possible in the absence of an instrument. Consistent with our results, Rissman (2013) reported that the rates of choosing an instrument for the verb *clean* were higher than the grand mean of the *allow*-instrument verbs. Since the verb *clean* patterned as require across the four languages in the present study as well as in Rissman (2013)'s, we are reclassifying the verb as a *require*-instrument verb.

calculate: The verb *calculate* was treated as requiring an instrument by over 50% of the speakers in English, Romanian, and Turkish, but not in Spanish. Koenig et al. (2008) classifies the verb *calculate* as merely allowing an instrument verb because calculating could use a machine, in the authors' terminology, to perform some action (i.e., a multiplication), but it does not have to. Calculating can be done without using an external instrument such as a calculator, however, perhaps the alternative is one's mental capacity, i.e., doing a mental calculation. Speakers often mentioned calculator or pen and paper in English, Romanian, and Turkish, but not in Spanish. Perhaps Spanish speakers were more likely to think of calculating as a mental operation, where the instrument would be a body part: one's brain. If that is the case, as we saw above, body part instruments are less likely to be explicitly mentioned.¹⁰

wash: The verb *wash* was a borderline case with approximately 50% of the speakers mentioning an instrument in English, Spanish, and Turkish and 75% in Romanian.

¹⁰Recruiting of Spanish speakers was conducted through the researchers' social media. Given my past involvement with a not-for-profit and knowledge of the demographics of the Spanish speakers in my network, there is a high chance many have not graduated high school. This may have biased their ideas of calculating to very straightforward tasks that may not require a calculator. This is however an assumption, and future studies could tap into this. For example, answers where no instrument was mentioned such as *the student*, *the problem* could be followed up by a question asking speakers whether they envisioned a mental calculation, pen and paper, or a calculator.

Rissman (2013) classified the verb as merely allowing an instrument because washing could be done without using an external instrument such as a sponge. The verb *wash* is tricky for two reasons. Firstly, though speakers were given the non-reflexive form in Spanish and Romanian, some interpreted the verb as reflexive, i.e., the distinction between washing something versus washing one's self. Because of this ambiguity, the verb was treated differently by different speakers. This leads to our second point, when the verb is treated as reflexive, the most likely instrument is a body part (their hands), whereas when it's not, the instrument may often be external: dishwasher, washing machine, detergent, sponge etc. The ambiguity as to whether the verb is reflexive or not along with the fact that body parts may be less likely to be stated explicitly than external instruments may explain why the verb did not pattern according to our expectations. To that end, we are excluding it from the final cross-linguistic analysis.

kill: The verb *kill* also showed some variety across languages, though the percentages only varied between 40% and 55%. These findings suggest that some verbs are borderline cases, such that they are perceived as merely allowing an instrument by some speakers and requiring one by others.

In sum, we reclassified the verb *clean* as requiring an instrument, eliminated the Spanish results for the verb *calculate*, and eliminated the verb *wash* in its entirety.

Cross-linguistic variation despite consistency in meaning

The verbs *vaccinate*, *dissect*, and *repair* were classified as allowing an instrument and patterned as such in some languages but not others.

vaccinate: More than 50% of the speakers mentioned an instrument for the verb

vaccinate in Turkish, Romanian, and English, but not in Spanish. Common instruments mentioned cross-linguistically were *a needle* or *a syringe*. A common answer in Spanish was *una inyección*, which typically refers to the medicine being injected such as the vaccine. However, it seems that in colloquial Spanish, *inyección* refers to the medicine and syringe, needle included, thus it encompasses the instrument. Since we don't know which meaning the speakers had in mind, we are excluding the Spanish results for this verb for the final analysis.

dissect: The verb *dissect* was perhaps the most surprising because though the meaning seems identical across the four languages, responses varied. Turkish and English speakers treated the verb as allowing an instrument with approximately 25% and 45% of the speakers respectively mentioning an instrument. Romanian and speakers treated the verb as requiring an instrument with approximately 60% and 75% of the speakers respectively mentioning an instrument. Since the speakers' responses are split as to whether *dissect* is a *require*-instrument verb or a *allow*-instrument verb, we are excluding it from the upcoming cross-linguistic analysis.

repair: The verb *repair* elicited an instrument in 40 to 60% of the speakers in English, Romanian, and Turkish and in 25% in Spanish. Cross-linguistic variability is to be expected; however, this particular verb is surprising because there seems to be no meaning difference between the languages.

The allow/require distinction cross-linguistically

Figure 4.21 illustrates how the 38 instrument verbs included in this study pattern with respect to the allow/require distinction.

Figure 4.21: Allow/require instruments in the semantic experiment across languages

4.6.5 Takeaways

In sum, findings revealed several factors that may contribute to the unclear status of instruments as arguments or adjuncts. Firstly, there was a semantics/syntax mismatch such that syntactically, instruments were virtually nonexistent, whereas semantically, they were prevalent. We concluded that syntactically, instruments behave as adjuncts. Within the semantic experiment, we provided cross-linguistic evidence for the allow/require distinction such that instruments are significantly more salient for *require*-instrument verbs than for *allow*-instrument verbs. However, this distinction is gradual rather than categorical suggesting that other factors may influence whether speakers mention an instrument or not. One potential factor may be the difference between *body parts* instruments and *external* instruments. *Require*-instrument verbs that take a body part instrument consistently patterned as *allow* across the four languages. On our interpretation, this suggests that speakers may perceive body part instruments, or *proper part* in Schlesinger's (2006) terminology, differently than external instruments.

Chapter 5

Verbs and their arguments in typical and atypical groups

5.1 Background

Theoretical accounts are often formulated based on data from a specific language or population. Checking the plausibility of these accounts in light of data from both typical and atypical populations is valuable as it can enhance their robustness, potentially refute them or cast doubt. This chapter is rooted in the idea that atypical development may shed light on typical development (Cicchetti and Rogosch, 1996; Cicchetti, 1996; Achenbach, 1987; Garnezy, 1992; Cicchetti, 1984, 1993), and more specifically, that pathology can provide insights into the human faculty of language (Roberts, 2017, p. 416).

Chapter 4 aimed to enrich our understanding of the argument/adjunct distinction whereas Chapters 5 and 6 investigate production of verbs and arguments in atypical populations. Along with theoretical motivations, these explorations have clinical

applications for language diagnosis and language training.

This study compares and contrasts the production of arguments in individuals with typical development, individuals with autism, and a third, less known group of individuals who were diagnosed with Autism Spectrum Disorder (ASD) early in their development but who, as teens, have no symptoms compatible with an ASD diagnosis. This group was originally said to have an “optimal outcome” and is currently called a “Loss of Diagnosis” (LAD) by the team that originally described them: Fein et al., 2013.

Autism Spectrum Disorder is of particular relevance to the current study because language difficulties are one of its core features (Rapin and Dunn, 2003). While semantic and pragmatic difficulties are well-established in autism, when it comes to grammar impairments, the picture is not quite so clear (Eigsti et al., 2007; Ambridge et al., 2015, for a review see Rapin and Dunn, 2003). Next, I outline support for as well as evidence against the claim that grammar is spared in ASD.

Findings indicating that grammar is spared in ASD. In a review of linguistic functioning in autism, Tager-Flusberg (1981) reported that children with ASD may experience semantic and pragmatic difficulties relative to children with typical development (TD). In terms of phonological and syntactic development, children in the two groups follow the same development (though the development may be slower in ASD). Tager-Flusberg et al. (1990) evaluated spontaneous language generation in children with autism and Down syndrome. The majority of children in both groups followed the same general developmental path as typically developing children in the literature in terms of grammatical and lexical language aspects.

Findings indicating that grammar is impaired in ASD. Bartolucci and

Albers (1974) found that children with ASD performed significantly worse than children with delayed development and children with TD in a past tense production task. Pierce and Bartolucci (1977) reported similar findings on measures of syntactic complexity (e.g., pronouns, conjunctions, as well as complexity of sentence transformations¹ such as question-formation and embedded sentences). Roberts et al. (2004) reported high rates of omissions of past tense marking in children with ASD. Subsequently, Eigsti and Bennetto (2009) reported that participants with ASD were significantly impaired in their ability to judge the grammaticality of sentences, specifically for third person singular and present progressive marking when compared to controls with typical development matched on chronological age, receptive vocabulary and IQ.

5.2 Argument structure in autism

Research on grammar in individuals with autism has yielded mixed findings; the field does not agree on whether grammar is spared or intact. Research that specifically addresses argument structure is quite scarce. There are six main papers: Prior and Hall (1979), Ambridge et al. (2015), Song et al. (2017), Horvath et al. (2018), Zhou et al. (2019), and Stockbridge et al. (2014) to date.

Horvath et al. (2018) assessed novel verb learning in autism in the absence of

¹Complexity of sentence transformations was assessed in light of Chomsky's transformational analysis (Pierce and Bartolucci, 1977). Sentences produced by the participants were written as a tree and evaluated in terms of the number and complexity of the transformations required to generate the surface production. For a sentence such as *He closed the door*, no transformation is required. A question such as *Can Tom eat over?* however, starts with the base form *Tom can eat over*. It requires an inversion of the modal *can* and the subject *Tom* to achieve the question form. Similarly, *The man who lives here bought a new car* starts with two base sentences *The man lives here* and *The man bought a new car*. The desired sentence is achieved through embedding.

visual or social context. Thirty-two children with ASD (2 to 5 years old) listened to transitive (80) and intransitive (81) sentences which introduced a novel verb such as **to biff**. Afterwards, they saw two side by side pictures denoting a causative event and a non-causative one, respectively.

(80) Mommy **biffed** the train.

(81) Mommy and the train **biffed**.

Children in both groups looked more at the causative scene in the transitive condition than in the intransitive condition. These findings indicate that children with ASD were able to assign meaning to a novel verb using syntactic information alone.

Zhou et al. (2019) and Stockbridge et al. (2014) assessed verb comprehension in ASD. In an eye-tracking experiment, Zhou et al. (2019) evaluated the use of verb information to anticipate upcoming linguistic input during real sentence comprehension in 26 preschoolers with ASD and 49 with TD. Children were presented with a drawing (e.g., boy, cake, bike and ball) as they listened to two kinds of sentences. The sentences were either biased for one object in the drawing (82) or neutral towards the objects in the drawing (83).

(82) The boy ate ... (biased towards **cake**)

(83) The boy found ... (neutral; **cake**, **bike** and **ball** are equally plausible objects)

Findings showed that the biased verbs triggered more fixations on the target area (**cake**) than neutral verbs did, suggesting that the ability to predict linguistic input based on the verb's meaning was preserved in autism.

Stockbridge et al. (2014) investigated dative constructions in autism. Specifically,

18 participants with ASD and 18 with TD aged 7 to 16 years were exposed to dative sentences (84). Their task consisted in identifying the recipient or indirect object.

- (84) a. Toby read Jenny the book.
 b. Toby read the book to Jenny.

The stimuli was presented visually and auditorily: as the text appeared on a computer screen, recordings were played concurrently. Participants were presented a sentence such as *Becky threw the ball to Jamie* followed by a question such as *Who was the ball thrown to?*. They had to select either *Becky* or *Jamie* by pressing a key below the answer. Findings showed that all participants preferred the prepositional construction (84-b) over the double object construction (84-a) with no differences between the two groups.

In a now quite old study, Prior and Hall (1979) compared verbal comprehension across children with ASD, children with developmental delays, and children with TD. Participants had to select from four pictures the one that illustrated a two-word intransitive (e.g., *man waving*) or three-word transitive phrase (e.g., *girl rides horse*) which was described verbally. The study found that children with autism performed significantly worse than the control groups. However, though performance was lowest in the group with autism, the hierarchy of difficulty was common across the three groups: transitive phrases were consistently more difficult than intransitive phrases.

In a more recent study, Ambridge et al. (2015) tested 16 children with ASD and 16 children with TD with a graded grammaticality judgment test. Children were presented with grammatical and ungrammatical sentences. Two types of verbs were used, alternating and non-alternating. Alternating verbs such as *open* can be used in one-argument constructions (85) and in two-argument constructions (86):

(85) The door opened in the hallway.

(86) Homer opened the door in the hallway.

Other verbs such as *appear* can only be used in one-argument constructions (87). These verbs are referred to as non-alternating verbs. When used in two-argument constructions (88), they render ungrammatical sentences:

(87) The coin appeared out of thin air.

(88) * Homer appeared the coin out of thin air.

The grammatical sentences consisted of alternating verbs in both constructions and non-alternating verbs in their one-argument construction (the only grammatical one). The ungrammatical sentences were achieved by using non-alternating verbs in two-argument constructions such as in (88) above.

The children saw a computer recording illustrating the event and concurrently heard the sentence. Their task was to rate the sentences on a 5-point scale ranging from ungrammatical to grammatical. The results suggest that children with ASD “showed a smaller dispreference for ungrammatical sentences.” Specifically, children with ASD rated ungrammatical sentences higher than children with TD did. Ambridge et al. (2015) considered this as an indication of grammar impairment, particularly of argument structure overgeneralization.²

²A different interpretation may be that both groups understand (88) as *Homer caused the coin to appear out of thin air*. In other words, the meaning is clear to children in both groups. With this assumption in mind, results could be an indication that children with ASD worry less about structure and are satisfied with understanding the meaning, regardless of ungrammaticality. On the other hand, children with TD may not be as forgiving. This would be a rather interesting finding, as it would imply that children with ASD are actually better at pragmatics than children with TD, contrary to the common finding that individuals with ASD often suffer from pragmatic impairment (Deliens et al., 2018).

Song et al. (2017) investigated argument structure in mental and action verbs in 15 children with high functioning ASD and 15 children with TD aged 7 to 8 years. Mental verbs are semantically defined as subjective by nature; they denote abstract feelings, intentions, and sensations, among others. Action verbs are objective; they denote actions that generally have a concrete visual representation (Song et al., 2017). Mental verbs are particularly challenging because their meaning may be less accessible due to subjectivity, and they have a tendency to select a complex argument structure. Consider the verb *find* used as an action verb in (89) and as a mental verb in (90):

- (89) He found the book.
- (90) a. He found nothing but confusion.
b. He found the plane has left without him.

When *find* is used in its concrete meaning (89), the verb's internal argument is a noun denoting the concrete object found such as the book. When used in its abstract meaning (90), the verb has alternate argument structures: its argument may be denoted by a noun (90a) or by a clause (90b) (Song et al., 2017).

The participants' task was to read a verb (mental/action) and make a sentence with it. Findings showed that while children in the TD group produced a more complex argument structure for mental verbs than for action verbs, children in the high functioning ASD group showed no difference between the two. Specifically, for mental verbs, children in the TD group produced arguments as both nominals and clauses whereas children in the high functioning ASD group produced nominals only. The authors however draw attention to the limitation of discourse generation tasks as a measure of syntactic generation. They point out that children with autism may

have the ability to produce longer sentences but may find it unnecessary and may be reluctant to do so.

The results reviewed above should be taken with a grain of salt (Eigsti et al., 2011) for two main reasons: sample size and changes in diagnosis criteria in autism over time. For example, Bartolucci and Albers' (1974) study included just three autistic, three developmentally delayed, and two typically developing children. This opens the path for further research into argument structure in this population.

5.3 Goals of the present study

With the overarching goal of better understanding the argument/adjunct distinction, this study investigates production of verbs, their arguments, and their adjuncts in adolescents with high functioning autism, 'Loss of Diagnosis', and typical development. Specifically, it addresses the following questions:

- Do speakers prefer verbs with few arguments over verbs with many arguments? If so, is this more prominent in adolescents with high functioning autism?
- Do adolescents with high functioning autism produce errors related to argument structure? If so, what is the nature of these errors, and how does the production of these errors compare to the errors produced by adolescents in the Loss of Diagnosis and the typically developing groups?
- Arguments are often discussed in relation to adjuncts. Is there a difference in adjunct production across groups?

I address these questions through an analysis of narrative stories.

5.4 Methods

Participants were presented with six black-and-white drawings depicting a story about two monkeys where one was stealing coconuts from the other, and eventually got caught in the act. The researcher told participants that they would be asked to tell the story shown in the cards and then laid out one picture card at a time. Participants were encouraged to examine each card for as long as they liked. The cards were removed, and participants were prompted to tell the story. The narrations were video recorded and transcribed. The data have been kindly shared by Dr. Inge-Marie Eigsti, from the University of Connecticut. For an in-depth overview of the original studies, please review Canfield et al. (2016) and Fein et al. (2013).

Participants

The subjects were adolescents with typical development (TD; $N = 15$, 10 to 16 years, $M = 12.93$), with ‘Loss of Diagnosis’ (LAD; $N = 14$, 9 to 17 years, $M = 12.98$), and with high-functioning autism (ASD; $N = 13$, 11 to 16 years, $M = 12.67$). Recall that ‘Loss of Diagnosis’ refers to individuals who were diagnosed with Autism Spectrum Disorder early in their development but who no longer meet the criteria and have typical behavioral functioning (Eigsti and Fein, 2013). Subjects in the LAD group were required to have a documented diagnosis of autism from a specialist in the field prior to the age of five and to no longer meet the diagnostic criteria for autism considering both the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and clinical judgment. To be included in the ASD group, subjects were required to meet the criteria for diagnosis of ASD on the basis of the ADOS, parent report, and clinical judgment by an expert clinician. Subjects did not differ in age or IQ. In

addition, they had to be in regular education classrooms with no special education services for ASD-related symptoms.

5.5 Results

Data coding and variables of interest

Story transcriptions were coded by the researcher and then compared with the same transcriptions tagged for parts of speech using the NLTK package in python for natural language processing (Bird et al., 2009) for consistency.

Given the focus on verbs and their participants, all verbs were identified and assessed on several criteria including: uniqueness, predicted argument structure, produced argument structure, expected number of arguments, and produced number of arguments. To facilitate reading, these criteria will be defined progressively as they become relevant.

Given the focus on argument structure, several verbs were coded as *other*. These verbs consisted of fillers, such as ‘you know’, ‘did I say ...’, ‘I’ll start again’, and auxiliary verbs such as ‘do’, ‘be’, and ‘have’. Such verbs were excluded from all analyses.³ For a list of verbs coded as *other*, see Appendix F.

I started with a broad evaluation of verb production across groups. Since the literature on argument structure in ASD is limited, and to the best of my knowledge, no previous study looked at argument structure in story narratives specifically, I evaluated the total number of verbs in two ways:

³All fillers were produced by individuals within the LAD group, with no productions by individuals with ASD or TD (all groups had auxiliary verbs). Moreover, the only instance of a speaker asking the researcher whether they said something and then restarting the story also pertains to an individual within the LAD group.

- **Types:** unique verb productions; each verb is counted just once⁴
- **Tokens:** individual verb occurrences; the total set of verbs, including repetitions

Consider a speaker has produced the following verbs: *get, throw, sit, steal, see, throw, come, steal, throw*. In total, the speaker has produced nine verbs, or nine tokens. However, the verbs *steal* and *throw* appear twice and three times, respectively. Once repetitions were removed, six unique verb productions or types remained: *get, throw, sit, steal, see, come*.

Verb production

This sections reviews descriptives for types and tokens, respectively.

Types

Table 5.1 illustrates how the production of verb types compares across groups once fillers, auxiliaries and repeats were excluded.

group	mean (<i>SD</i>)	range	mode
ASD	9.77 (<i>2.52</i>)	6 - 14	7
LAD	12.23 (<i>3.50</i>)	8 - 22	12
TD	13.80 (<i>3.47</i>)	8 - 23	12

Table 5.1: Verb types by group

In the case of verb types, the LAD and TD groups patterned together with higher values than the ASD group on all measures (mean, range and mode). Figure 5.1 is a density plot illustrating the number of verb types by group.

⁴This includes variations of the same verb such as *throw* and *throws*.

Figure 5.1: Production of verb types by group

Tokens

Table 5.2 illustrates how the production of tokens (i.e., repetitions included) compares across groups.

group	mean (<i>SD</i>)	range	mode
ASD	12.77 (3.34)	6 - 18	14
LAD	19.43 (8.40)	11 - 42	15
TD	19.53 (5.07)	12 - 30	20

Table 5.2: Verb tokens by group

Once again, adolescents in the ASD group produced the lowest number of verbs. Adolescents in the LAD and TD groups patterned together, as indicated by the mean and range.⁵ The mode however suggests that individuals in the LAD and ASD group pattern together. Figure 5.2 illustrates the production of verb tokens by group.

⁵Though the range for LAD may stand out as it goes up to 42 verbs while TD has a max of 30, that is misleading as there is only one value of 42, and the next highest value is 30. That is why I am saying TD and LAD are similar in mean and range. This is also why the *SD* in LAD is the highest among the three groups.

Figure 5.2: Production of verb tokens by group

Taken together, results indicate that adolescents in the ASD group produced fewer types and tokens overall than adolescents in the LAD and TD groups. Secondly, the gap between individuals with ASD and LAD, as well as between individuals with ASD and TD, respectively, is larger when considering tokens than when considering types only. This reveals that adolescents in the LAD and TD groups achieved longer stories by two means: 1) by producing more types, or more unique verbs, and 2) by repeating verbs, thus, producing more tokens, with the second being a larger contributor to story length.

Argument structure across groups

After gaining an understanding of the overall verb production across groups, I explored the verbs chosen by the speakers, the production of arguments, as well as argument structure-related errors. This set of analyses was conducted using *tokens*; fillers and auxiliaries were excluded. Repetitions were included because as a verb is

used several times, it may be used in a different subcategorization, or it may contain errors in some instances but not others.

Verb choices and number of arguments produced

I started by exploring what sorts of verbs the speakers produced in terms of their argument structure. Specifically, I was interested in whether there is a preference for verbs that take one or two arguments over verbs that take three (Thompson et al., 2010; Meltzer-Asscher et al., 2015; Shetreet et al., 2006; Ben-Shachar et al., 2003; den Ouden et al., 2009, a.o.). All verbs produced were classified based on the maximum number of arguments they take. For example, *cry* takes one argument (*someone cries*), thus, it was coded as a one-argument verb; *miss* takes two arguments (*someone misses someone/something*), thus, it was coded as a two-argument verb; and *teach* takes three arguments (*someone taught someone something*), and was coded as a three-argument verb.⁶ I refer to this feature as *predicted argument structure*. Table 5.3 illustrates the number and frequency of verb types based on their predicted argument structure by group.

group	1-argument	2-arguments	3-arguments	total
ASD	49 (29.52)	87 (52.41)	30 (18.07)	166 (100)
LAD	66 (24.26)	155 (56.99)	51 (18.75)	272 (100)
TD	84 (28.67)	156 (53.24)	53 (18.09)	293 (100)
Total	199 (27.22)	398 (54.45)	134 (18.33)	731 (100)

Table 5.3: Number and frequency of verb types by group

Table 5.3 shows that individuals with ASD produced less verbs than individuals with LAD, and individuals with LAD less than individuals with TD. Individuals in the

⁶Perhaps it is worth mentioning that the most common three-argument verbs were *drop* and *throw*.

LAD group patterned closer to individuals in the TD group than to individuals in the ASD one. All groups preferred two-argument verbs ($> 50\%$) over one-argument verbs, and one-argument verbs over three-argument verbs, which were produced the least. The results are consistent with the claim that two-argument verbs are most common (O'Dwyer, 2006).

Next I compared *expected* and *produced* arguments. *Expected arguments* is the numeric equivalent of the *predicted argument structure*. For example, the verb *miss* is a two-argument verb; thus, it involves two arguments. *Arguments produced* is the actual number of arguments produced by the speaker. For example, *give* involves three arguments (the giver, the object being given, and the receiver). If the speaker said *I gave the coconut to Sam*, the response was coded as having three produced arguments. If the speaker said *I gave the coconut*, the response was coded as having two produced arguments. Table 5.4 illustrates the means of the expected and produced number of arguments, as well as for the difference between expected and produced, by group.

group	mean (<i>SD</i>) produced	mean (<i>SD</i>) expected	mean (<i>SD</i>) difference
ASD	1.71 (<i>0.68</i>)	1.89 (<i>0.68</i>)	0.18 (<i>0.41</i>)
LAD	1.81 (<i>0.60</i>)	1.94 (<i>0.66</i>)	0.13 (<i>0.35</i>)
TD	1.79 (<i>0.61</i>)	1.89 (<i>0.67</i>)	0.10 (<i>0.32</i>)

Table 5.4: Produced and expected number of arguments by group

Speakers in all groups produced less than the expected number of arguments. The difference between the numbers of arguments expected and produced reveals whether one group was more likely to produce all arguments. I ran the Kruskal-Wallis rank sum test⁷ to assess whether the three groups differed in the likelihood to produce all

⁷The Kruskal-Wallis rank sum test is a non-parametric alternative to one-way ANOVA used when

arguments. The test revealed no significant difference among the three groups, $\chi^2 = 2.99$, $p = 0.06$. Trend-wise, the difference was higher in adolescents with ASD than in adolescents with LAD, and in adolescents with LAD than in adolescents with TD.

The results so far indicate that speakers prefer two-argument verbs over one- and three-argument verbs. Individuals with ASD were least likely to produce all arguments of a verb, followed by individuals with LAD who fell in between, but pattern closer to typically developing individuals, though the difference is not significant. However, the results so far do not tell us whether any of the missing arguments were obligatory, or whether there were any argument structure errors. With that in mind, next I investigated argument structure completion, and then further explored the nature of the arguments produced.

Argument structure completion

Argument structure completion was assessed for each verb relative to the predicted argument structure. I named the feature *produced argument structure* and coded it as: *max*, *max - repaired*, *< max*, or *erroneous*. As discussed earlier, the verb *miss* is a two-argument verb. If the speaker produced both arguments, the response was scored as *max*. If the speaker made an error and self-corrected, the response was scored as *max - repaired*. If the speaker omitted an optional argument, the response was coded as *< max* indicating that not all arguments were produced. In all these three cases, *max*, *max - repaired*, *< max*, the use is still grammatical.

If the speaker omitted an obligatory argument, the response was coded as *erroneous*, since missing an obligatory argument renders the use ungrammatical. For the ANOVA assumptions are not met (in the present case, the normality assumption was violated).

example, if the speaker produced *missed* rather than *I missed*, the response was coded as *erroneous* because the subject is missing. Similarly, the response was also coded as *erroneous* if the speaker omitted an obligatory object as in *he uses* instead of *he uses something*.

Table 5.5 illustrates the produced argument structure by group. Specifically, it captures whether given a verb, all potential arguments were listed (max), any errors were caught and repaired by the speaker (max - repaired), less than all arguments were listed but without affecting its grammaticality (< max), and the argument structure was erroneous.

group	max	max repaired	< max	erroneous
ASD	78.31%	0.60%	12.05%	9.04%
LAD	83.46%	0.74%	11.03%	4.78%
TD	90.78%	0.68%	8.19%	0.34%

Table 5.5: Argument structure completion

Adolescents with TD had the highest percentage of complete argument structure, followed by adolescents with LAD, and then by adolescents with ASD, consistent with our previous results where the difference between expected and produced arguments was the lowest in adolescents with TD, followed by adolescents with LAD, and the highest in adolescents with ASD. All groups had negligible repairs. All groups had erroneous argument structure, with ASD producing the highest number of errors. For examples of errors by group, see Appendix F.

I also looked at adjunct production, which did not differ across groups. Perhaps worth mentioning though is that only individuals in the LAD group elicited adjunct-related errors. I then analyzed the types of adjuncts such as time, place, manner, and reason. Once again, no trends emerged.

5.6 Discussion

This chapter presented a novel approach to assessing grammar in autism, by evaluating argument structure features in narrative stories. In a nutshell, individuals with ASD had the most errors and produced the least verbs, followed by individuals with LAD. Typically developing individuals had negligible errors and the longest stories.

Findings show that individuals with ASD produced less verbs than individuals with LAD and with TD. However, the gap between groups narrowed when accounting for repetitions. Thus, the fact that individuals with ASD produced shorter stories does not necessarily imply a weaker vocabulary; other factors may be at play. These findings may indicate of a mismatch between production and comprehension. It may be the case that individuals with ASD differ only marginally from their peers with TD in their knowledge of verbs (i.e., they know the same number of unique verbs), consistent with Zhou et al. (2019) who reported intact verb comprehension in autism.

Based on Prior and Hall (1979), I predicted that all groups will prefer verbs with fewer arguments over verbs with more arguments. Findings showed that three-argument verbs were indeed least preferred by all groups. However, two-argument verbs were preferred not only over three-argument verbs, but also over one-argument verbs. This may be because two-argument verbs are most common (O'Dwyer, 2006). The results may also have been driven by the task at hand. Speakers told stories based on picture stimuli where the protagonists, two monkeys, picked, stole and threw coconuts, thus, to accurately describe the stories, speakers had to resort to two-argument verbs at least.

I started out asking whether the LAD group patterns with the ASD group or the TD group. Findings revealed that their linguistic profile does not perfectly match

either group. Though as a trend only, the LAD group fell in between the ASD and TD groups. Ranges and standard deviations point towards heterogeneity within the LAD group. In light of this, the next chapter further explores language (and autism) profiles in the three groups appealing to a method that address the heterogeneity within the groups.

Chapter 6

Exploring within-group heterogeneity

6.1 Background

The previous chapter investigated argument structure in adolescents with high functioning autism (ASD), with Loss of Diagnosis (LAD), and with typical development (TD). Results revealed clear differences between adolescents in the ASD and TD groups. The LAD group, however, led to mixed findings. It patterned with the TD group on the number of verbs produced; fell in between the ASD and TD groups on argument structure errors; and had the most fillers among the three groups. The present chapter aims to better understand the characteristics of adolescents within the LAD group.

6.2 Adolescents with Loss of Diagnosis

Autism is a neuro-developmental condition characterized by variation in brain function and development (Georgiades and Kasari, 2018). Thus, it is thought to be a lifelong condition. There is however evidence suggesting that some individuals do recover from ASD (Fein et al., 2013). This subgroup is sometimes referred to as ‘optimal outcomes’: they have achieved “the best possible outcome considering a child’s history” (Costello and Maughan, 2015; Georgiades and Kasari, 2018). The current focus is to better understand the characteristics of individuals with LAD, and I remain neutral as how to best refer to this group, though it is undoubtedly important.

Previous research shows that the LAD and TD groups performed similarly on their ability to hear different pitches and tones, both performing significantly weaker than ASD (Eigsti and Fein, 2013). In fact, identifying pitch differences is thought to be a special ability of ASD (Eigsti and Fein, 2013). They also performed similarly on measures of socialization, communication, face recognition, and most language subscales (Fein et al., 2013), as well as on their production of the filler *um* (Irvine et al., 2016). On measures of executive functions, though the LAD group’s performance fell within the average range, the LAD and high functioning ASD groups exhibited more impulsivity, less efficient planning and problem solving, set shifting, and working memory than the TD group (Troyb et al., 2014).

I expanded the analysis to include autism-standardized measures used in diagnosing ASD¹ as well as a commonly used language assessment (Clinical Evaluation of Language Fundamentals; CELF). These measures allowed for a broader understand-

¹These measures were evaluated in the original studies by Canfield et al. (2016) and Fein et al. (2013). The present study conducts a secondary analysis using a different statistical method, unsupervised learning, which I introduce in Section 6.5.

ing of the profile of the LAD group. Next I review some of the argument structure measures discussed earlier and provide a brief description of the autism-standardized measures and the CELF:

Measures related to argument structure

- **all verbs:** all verbs produced
- **expected arguments (exp args):** the (maximum) number of arguments a verb can take. For example, the verb *give* is predicted to take three arguments (the giver, the object, and the receiver). This measure is of interest because I hypothesize that speakers with language difficulties will have a harder time producing verbs that involve a higher number of arguments.
- **produced arguments (prod args):** the actual number of arguments produced by the speaker. Revisiting the verb *give*, if the speaker said *I gave the coconut to Sam*, the response was coded as having three produced arguments. If the speaker said *I gave the coconut*, the response was coded as having two produced arguments. This measure is used to compute the **difference between arguments produced and arguments expected (args diff)**.
- **difference of arguments produced and arguments expected (args diff):** a difference of zero means that the speaker produced all of the verb's arguments. A difference greater than zero indicates that the speaker produced less than the maximum number of arguments.

Measures related to ASD diagnosis

- **Autism Diagnostic Observation Schedule (ADOS)**: gold standard assessment for ASD diagnosis (Canfield et al., 2016; Lord et al., 2002) including measures of:
 - **Communication** (comm)
 - **Social**
 - **Repetitive behaviour** (repbeh)
 - **Imagination** (imag)

Standardized language assessment

- **Clinical Evaluation of Language Fundamentals; CELF**: an assessment of receptive and expressive language skills (Canfield et al., 2016; Semel et al., 2003)

6.3 Goal of the present study

This chapter presents an exploratory analysis of the characteristics of adolescents with Loss of Diagnosis. Specifically, it addresses the same overarching question discussed in Chapter 5:

- Do adolescents within the LAD group pattern with adolescents in the ASD group or the TD group?

I address this question by means of group comparisons (Section 6.4) and by unsupervised learning (Section 6.5).

6.4 Group comparisons

Chapter 5 presented mostly descriptive statistics. The present section evaluates whether the differences between the three groups (ASD, LAD, TD) reached significance.

6.4.1 Results

The one-way ANOVA and the Kruskal–Wallis test² were used to evaluate whether adolescents in the three groups differed on their scores on argument structure measures, a standardized language test, and ADOS measures. Table 6.1 illustrates the results for the one-way ANOVA and the Kruskal–Wallis tests, respectively. It shows the F value for the ‘args diff’ measure which did meet the ANOVA assumptions and the χ^2 corresponding to the Kruskal–Wallis test for the other measures which did not meet the ANOVA assumptions. It also shows the *p*-values associated with each test.

	measure	F or χ^2	<i>p</i>
argument structure measures	all verbs	13.15	0.001
	exp args	2.01	0.37
	args diff	2.99	0.06
standardized language test	CELF	7.92	0.001
ADOS measures	comm	28.35	<0.001
	social	29.19	<0.001
	repbeh	22.77	<0.001
	imag	3.32	0.19

Table 6.1: ANOVA/the Kruskal–Wallis test for tokens

The groups differed significantly on the ‘all verbs’, the CELF, and the ADOS measures

²The Kruskal–Wallis test is a non-parametric alternative to the one-way ANOVA and was used when the ANOVA assumptions were not met.

except imagination. Then I followed up on these significant differences with pairwise comparisons.

Argument structure measures

Table 6.2 below shows the results for the ‘all verbs’ measure which reached significance and the ‘args diff’ measure which approached significance.

all verbs		
	ASD	LAD
LAD	0.02	-
TD	<0.001	0.97
args diff		
	ASD	LAD
LAD	0.33	-
TD	0.05	0.59

Table 6.2: Pairwise comparisons (p -values) for ‘all verbs’

The LAD group patterned with the TD group on the ‘all verbs’ measure. Both differed significantly from the ASD group. The ‘args diff’ shows that the three groups did not differ in their likelihood to mention all arguments, though the TD and ASD groups approached significance.

Clinical Evaluation of Language Fundamentals (CELF)

Table 6.3 below shows the results for CELF.

	ASD	LAD
LAD	0.10	-
TD	<0.001	0.15

Table 6.3: Pairwise comparisons (p -values) for CELF

The pairwise comparisons revealed that the TD and ASD groups differed significantly

on their CELF score. The LAD group did not differ significantly from either the TD or ASD groups. This may be because the scores of the LAD group fell in between those of the ASD and TD groups, respectively. Table 6.4 illustrates the mean CELF score by group.

group	M (<i>SD</i>)
ASD	100.69 (14.69)
LAD	110.57 (13.44)
TD	119.20 (8.16)

Table 6.4: CELF scores by group

As Table 6.4 indicates, the mean CELF score of the LAD group indeed fell in between those of the TD and ASD groups.

Autism Diagnostic Observation Schedule (ADOS)

Table 6.5 below shows the results for ADOS communication, social, and repetitive behaviours.

communication		
	ASD	LAD
LAD	<0.0001	-
TD	<0.0001	0.49
social		
	ASD	LAD
LAD	<0.0001	-
TD	<0.0001	0.29
repetitive behaviour		
	ASD	LAD
LAD	<0.0037	-
TD	<0.0011	0.05

Table 6.5: Pairwise comparisons (*p*-values) for ADOS

The pairwise comparisons for the three ADOS measures (communication, social, and

repetitive behaviour) revealed that the TD and LAD groups differ significantly from the ASD group, but not from each other. In other words, the TD and LAD groups patterned together on the ADOS measures. This was expected given that adolescents in the LAD group no longer meet the criteria for diagnosis.

Interim summary

The results above are unclear with respect to the status of the LAD group. The LAD group patterned with the TD one on argument structure measures and ADOS measures (except imagination), and fell in between the TD and ASD groups on CELF not differing significantly from either group. These mixed findings may be in part due to the heterogeneity within the LAD and the ASD groups. Figure 6.1 illustrate the data by groups for the variables that reached or approached significance.

Figure 6.1: Scatter plots of all measures by group: tokens, args difference, CELF, and ADOS (communication, social, and repetitive behaviour).

6.4.2 Discussion

The previous chapter investigated argument structure measures across the TD, LAD, and ASD groups. Section 6.4 above further explored these measures and included scores from receptive and expressive language skills as assessed by the CELF and Autism Diagnostic Measures of communication, social, imagination, and repetitive behaviour (ADOS; comm, social, imag, and repbeh) in the analysis.

Speakers differed significantly in the ‘all verbs’, CELF, and ADOS measures (except imagination). Follow-up pairwise comparisons revealed complex findings such that the LAD group patterned with the TD group on ‘all verbs’ and on the three ADOS measures, and was in between the ASD and TD groups on CELF. In other words, different assessment measures placed the LAD group on a different side of the spectrum.

I asked whether adolescents with LAD pattern with adolescents with TD or with ASD. However, the results are unclear with respect to the profile of the LAD group. These mixed findings may be in part due to the spread (heterogeneity) of the data in the LAD group as showed in Figure 6.1 above. To address this, the next section employed a statistical method known as K-means clustering which addresses variability within the group.

6.5 K-means clustering

The unclear profile of the LAD group may be explained, in part, by the variability within the group. In an evaluation of parental interactions with preschool children in book sharing, Hammett et al. (2003) posited *the need for a methodological shift*

to account precisely for groups where variability is the norm rather than the exception. In the context of parent-child book sharing, the authors remarked that “given that variability appears to be the norm, it is surprising that researchers have rarely attempted to explore it in systematic and meaningful ways” (Hammett et al., 2003). Research in autism is in a similar state, evaluating differences among groups rather than individuals, despite the fact that autism is a spectrum condition. Given the enormous variability in the language profiles of ASD (Fein et al., 2013; Georgiades and Kasari, 2018; Zhou et al., 2019), clustering analyses serve as a complementary statistical method. Clustering is an empirical technique designed to divide a heterogeneous group in homogeneous subgroups (Speece, 1990; MacQueen, 1967). In contrast to more familiar statistical methods (e.g., ANOVAs), clustering analyses account for within-group variability by looking at each individual rather than only at the group level (Speece, 1990). K-means clustering (MacQueen, 1967) is one of the simplest and most well-known clustering algorithms. K-means clustering takes a set of elements represented as feature vectors and a number k of desired clusters and goes through the following steps (MacQueen, 1967):

1. selects k elements as centers for the initial k clusters,
2. assigns each element to a cluster with the closest center based on a distance function (such as mean),
3. recalculates the cluster’s center,
4. and lastly, it reiterates steps 2) and 3) until it reaches convergence, i.e., until the centre and members of the cluster no longer change with new iterations.

The next intuitive question concerns how one determines the correct number of clusters. Though researchers tend to make sense of the data after obtaining the clus-

ters, that is not a good approach (Speece, 1990). If the number is selected arbitrarily, “one will always get subtypes regardless of whether there exists a system for interpretation” (Speece, 1990), thus, k-means clustering should be used “in close interaction with theory and intuitions” (MacQueen, 1967). To address this, I stated my predictions based on the research questions a priori. Recall the three groups: TD, ASD, and LAD, where where adolescents in the LAD group were diagnosed with autism in the past, but no longer meet the criteria. The aim was to investigate whether adolescents with LAD pattern with adolescents with TD. If the TD and LAD groups indeed pattern together, two clusters would best describe the data. Otherwise, if the LAD group has characteristics different than those of the TD and ASD groups, three clusters would best describe the data.

Adolescents with LAD did not meet the ADOS criteria for diagnosis. With that in mind, the ADOS diagnostic measures serve as a control to illustrate the reliability of the k-means clustering method. Next, I used the same method on the measures related to argument structure and the CELF to better understand the characteristics of the LAD group.

In what follows, I review clustering results for the measures identified as significant in Table 6.1. Given our overarching focus on argument structure, I report clustering results on all measures of argument structure.

6.5.1 K-means clustering on ADOS measures

Adolescents in the LAD group did not meet the ADOS criteria for diagnosis. Thus, the LAD and TD groups should pattern together on the ADOS measures. In that case, the variability in the data should be best explained by two clusters. As a test,

I clustered the data with both two ($k = 2$) and three ($k = 3$) clusters to confirm whether indeed the TD and LAD groups pattern together and whether the data are best described by two clusters. To our surprise, two clusters explained 72.5% of the variability in the data whereas three clusters explained 83.2% of the data. Table 6.6 below shows the clustering results when considering the ADOS communication, social, and repetitive behaviours features.

Two clusters (k=2)			
cluster	ASD	LAD	TD
1	13	0	0
2	0	14	15
Three clusters (k=3)			
cluster	ASD	LAD	TD
1	8	1	0
2	5	0	0
3	0	13	15

Table 6.6: Clustering for ADOS measures

Table 6.6 shows that when clustering the data into two clusters all of the adolescents with ASD formed a cluster (1); the adolescents with LAD and TD formed another cluster (2). This is consistent with our prediction that the LAD and TD groups will pattern together, given that adolescents in the LAD group no longer meet the diagnostic criteria for autism.

When clustering the data into three clusters, once again the adolescents with LAD (13 out of the 14) and TD formed their own cluster (3). It is important to point out that three clusters are necessary not because the LAD and TD groups did not pattern together, but because the ASD group is best explained as consisting of two subgroups. Adolescents with ASD are divided into clusters 1 and 2.

In sum, k-means clustering on ADOS measures successfully clustered adolescents

with LAD and TD together, as expected. Additionally, the method revealed that based on their performance on the ADOS tasks, the adolescents with ASD in this study can be classified into two subgroups.

6.5.2 K-means clustering on argument structure measures

All verbs: Clustering the data into two clusters explained 63.0% of the variability whereas clustering it into three clusters explained 83.2% of the variability. Given that three clusters explained approximately 20% more variability in the data than two clusters, I limit the discussion to three clusters. Table 6.7 below shows the results for the ‘all verbs’ feature.

Three clusters (k=3)				
cluster	ASD	LAD	TD	cluster mean
1	0	3	2	31.60
2	3	5	10	18.72
3	10	6	3	12.42

Table 6.7: Clustering for all verbs

The *cluster mean* column illustrates the average number of all verbs produced by participants within that cluster. For example, Table 6.7 shows that cluster 1 consists of three LAD and two TD participants, and the average of verbs produced is 31.60 verbs. In other words, participants in cluster 1 produced the stories with the highest number of verbs.

The majority (37 out of 42) of the participants are divided between the remaining two clusters, which are both comprised of participants from all three groups. Of interest to us is that while there were no significant differences between the LAD and TD groups, 6 participants with LAD are in the cluster with the lowest verb

production, along with 10 participants with ASD and 3 participants with TD (cluster 3).

Expected arguments: Clustering the data into two clusters explained 56.8% of the variability whereas clustering it into three clusters explained 80.9% of the variability. Similar to the ‘all verbs’ feature, since three clusters explained more variability than two, I limit the discussion to three clusters. Table 6.8 below shows the results for the ‘expected arguments’ feature.

Three clusters (k=3)				
cluster	ASD	LAD	TD	cluster mean
1	4	10	4	2.03
2	8	3	11	1.84
3	1	1	0	1.49

Table 6.8: Clustering for expected arguments

The *cluster mean* column illustrates the average number of expected arguments within that cluster. As shown in Table 6.8, clusters 1 and 2 consist of participants from all three groups, and are relatively close in their cluster average. Based on the ‘expected arguments’ measure, most adolescents within the three groups seem to pattern together. For example, cluster 2 includes most of the TD and ASD speakers.³

Cluster 3 is comprised of one LAD and one high functioning ASD participant. The cluster mean of 1.49 suggests that these two speakers produced verbs that take less arguments overall, suggesting a potential avoidance of verbs with increased argument structure. Traditional group comparisons (ANOVA) revealed no significant differences among groups. Clustering, however, identified two speakers who produce low argument structure verbs relative to their peers.

³Recall however, that though adolescents in the three groups may have produced verbs with similar argument structure, this measure does not tell us whether they have produced all arguments or whether they had any errors. These details were discussed in Chapter 5.

The last argument structure measure was the difference of produced and expected arguments. This feature resulted in clusters consisting of participants from all three groups when using two and three clusters, respectively. Thus, it did not provide additional insights into the characteristics of the LAD group aside from highlighting that there is heterogeneity within each of the three groups.

6.5.3 K-means clustering on the CELF measure

On the CELF clustering measure, two clusters explained 72.9% of the variability in the data while three clusters explained 84.4% of the variability. Table 6.9 below shows the results for CELF for three clusters, since three better describe the variability in the data.

Three clusters (k=3)			
cluster	ASD	LAD	TD
1	1	4	7
2	7	3	0
3	5	7	8

Table 6.9: Clustering for CELF

Earlier pairwise comparisons found a significant difference between the TD and ASD groups and gave us no insight into the LAD group as it did not reach significance when compared to either the ASD or TD groups. Clustering provides further insight as looking at k=3 explains why LAD did not reach significance. Importantly, it is not because the values of LAD are exactly in the middle of those of ASD and TD as one might have predicted, but because of the variability in the data.

6.5.4 Discussion

Section 6.4 showed that the TD and LAD groups patterned together on ADOS measures (except imagination), and both were significantly different than the ASD group. Given that participants with LAD were tested on ADOS measures for the purpose of their diagnosis - which they no longer meet - they would pattern with TD. Thus, in Section 6.5, the ADOS measure served as a proof of concept, to see whether participants would cluster as predicted, which they did. With this validation, I proceeded with clustering on other measures. Aside from serving as proof of concept, clustering on the ADOS measures revealed that the ASD group is best described by two clusters, highlighting the heterogeneity within the ASD group.

When looking at the number of tokens produced, ANOVA indicated that the TD and LAD groups pattern together, with no significant differences between the two. Clustering however revealed that 6 adolescents with LAD patterned closer with 10 adolescents with ASD. Similar findings were observed on the CELF measure: one again, the lack of significance was not indicative of the LAD group being between the TD and ASD ones. For the expected arguments measure, it revealed that two adolescents (1 with ASD and 1 with LAD) produced verbs with a much lower number of arguments than their peers.

Taken together, these findings suggest that using a clustering analysis to complement traditional group comparisons such as ANOVAs has two main advantages: firstly, it provides further insight into measures where ANOVAs reveal no significant differences, and secondly, it helps identify unique behaviours of a small subset of participants that do not follow group tendencies.

Chapter 7

Final remarks

This thesis investigated the argument/adjunct distinction through two complementary approaches. Firstly, it addressed the argumenthood status of instrument phrases, which are notoriously difficult to classify as arguments or adjuncts. Secondly, it investigated the production of arguments and adjuncts in two atypical populations, with the underlying assumption that pathology provides insight into the human faculty of language.

Chapters 1 and 2 introduced the argument/adjunct distinction and provided evidence of its psychological reality from speakers' judgements, theoretical linguistics, psycho- and neuro-linguistics, as well as clinical evidence. On one hand, the first two chapters highlighted that the argument/adjunct distinction is clear, intuitive, and widely accepted across theories. On the other, they reviewed a wide selection of semantics/syntax mismatches. Semantic and syntactic obligatoriness are the most basic argumenthood diagnostic tests. A phrase that fails either test is particularly difficult to classify as an argument or an adjunct. I hypothesized that this semantics/syntax mismatch may contribute to the unclear status of instruments.

Chapter 3 highlighted that current literature yields mixed results regarding the status of instruments. Additionally, it hypothesized various factors that may further add to the difficulty of determining their status. To start with, even the most basic task of defining instruments is challenging, with different authors positing a different definition. Furthermore, those definitions are seldom explained or formalized (Rissman, 2013). Secondly, instruments do not form a unified class. Schlesinger (2006) described 10 distinct categories of instruments ranging from traditional ones such as tools used for cutting (e.g., ‘a knife’) to abstract entities that denote manner (e.g., ‘with patience’). One of the 10 categories, instruments denoting body parts, is particularly understudied, though researchers have posited that speakers may perceive body-part instruments differently than external tools. Last but not least, Chapter 3 discussed the allow/require distinction: instruments may be obligatory for some verbs, such as a sharp tool for chopping, and merely allowed for others, such as something to drink with (e.g., ‘a straw’ or ‘a cup’). In sum, Chapter 3 highlighted that instruments are not a unified class, but a heterogeneous one.

Chapter 4 investigated the argumenthood status of instruments cross-linguistically, in English, Romanian, Spanish, and Turkish. Within each language, I conducted two experiments. One explored the status of instruments at the semantic level, whereas the other explored their status at the syntactic level. I asked whether the allow/require distinction may contribute to explaining the status of instruments such that instruments are arguments for *require*-instrument verbs and adjuncts for *allow*-instrument verbs.

Despite subtle lexical semantic differences, findings were surprisingly similar cross-linguistically. As a whole, the investigation revealed the following generalization:

instruments pattern differently at the semantic and syntactic level. The syntactic experiment consistently identified instruments as adjuncts across the four languages. This conclusion is supported by the syntactic diagnostic tests reviewed in Chapter 3.

Semantically, results were also consistent across languages with *require*-instrument verbs eliciting significantly more instrument mentions than *allow*-instrument verbs. One interpretation may be that instruments are arguments for *require*-instrument verbs and adjuncts for *allow*-instrument verbs. However, that is unlikely given that the allow/require distinction was gradual rather than categorical, consistent with Rissman (2013) and Rissman et al. (2015). An alternative interpretation is that the argument/adjunct distinction itself is not categorical, and instruments have properties of both arguments and adjuncts.

A third and my preferred interpretation is that instruments are adjuncts, but semantically, they are salient participants. They have a privileged role in human cognition. We've seen that themes were mentioned both in the semantic and syntactic experiments by the majority of the speakers in all four languages. Goals and recipients, though less prevalent than themes, were also mentioned both semantically and syntactically. Themes are often syntactically obligatory, however, at least some indirect objects are syntactically optional arguments. Additionally, Turkish allows argument-drop quite freely, thus neither direct nor indirect objects were syntactically obligatory. Yet, they were still mentioned. Instruments however were syntactically nonexistent cross-linguistically, yet semantically, they were more prevalent than indirect objects in all four languages.

Regardless of what exactly the status of instruments is, this thesis provided cross-linguistic evidence that the semantics/syntax mismatch, the allow/require distinction,

and the body-part/external instrument distinction all contribute to whether instruments are explicitly stated.

Chapters 5 and 6 investigated production of arguments and adjuncts in adolescents with typical development, with Loss of Diagnosis, and with high functioning Autism Spectrum Disorder. As a whole, these two chapters led to two major contributions: Chapter 5 introduced a novel approach to assessing language differences across groups by evaluating measures of argument structure such as argument structure complexity, argument structure completion, and omission of obligatory arguments; Chapter 6 presented a complementary method of analysis particularly useful when looking at groups where heterogeneity is the norm rather than the exception. While the groups differed in the number and types of arguments produced, mentions of adjuncts were negligible in all three groups.

Appendix

A. English version

Verb stimuli

Transitive	Ditransitive	Allow	Require
kiss	give	kill	slice
lick	deliver	attack	cut
sniff	sell	wash	chop
bite	send	clean	stab
grab	pour	paint	stir
pull	throw	break	hit
pinch	bring	lift	draw
hug	tell	open	beat
kick	ask	eat	write
meet	buy	drink	dig
own	promise	charm	touch
believe	feed	defend	dissect
say	force	defeat	carve
destroy	encourage	calculate	scratch
build	recommend	harvest	mow
shoot	persuade	watch	comb
chase	advise	administer	vaccinate
spill	lend	repair	sweep
freeze	show	inspect	handcuff

Verb stimuli

B. Romanian version

Demographic questionnaire/Chestionar de date factuale

Instrucțiuni: Vă rog să răspundeți la întrebările care urmează, conform cunoștințelor dumneavoastră.

1. Vă rog să selectați vârsta dumneavoastră:

☐ 18-22 ☐ 23-40 ☐ 41 și peste

2. Sex:

☐ Masculin ☐ Feminin

3. Vă rog să indicați care este prima limbă vorbită:

☐ Romană ☐ Spaniolă ☐ Engleză ☐ Franceză ☐ Turcă

4. Care a fost prima limbă vorbită în casa dumneavoastră în anii copilăriei?

5. Dacă româna nu este prima limbă, la ce vârstă ați început să învățați română.

Semantic study instructions

Chestionar de limbă:

Imaginați-vă că următoarele activități se desfășoară într-o cutie mare și **goală**. Ce trebuie să fie (ce este **necesar**) în această cutie (oameni, obiecte, locuri și așa mai departe) pentru ca activitatea respectivă să se poată desfășura?

De exemplu, considerând activitatea de **a devora**, posibile răspunsuri includ:

1. cineva să devoreze și ceva să fie devorat (un om și o pizza)

Deasemenea, considerând activitatea de **a servi**, posibile continuări includ:

1. cineva să servească și ceva să fie servit (un chelner și o supă rece)
2. cineva să servească, ceva să fie servit, și cineva să fie servit (un chelner, o supă rece, și o femeie)
3. cineva să servească, și cineva să fie servit (un chelner și o femeie)

Experimentul 1: elicitând intuițiile semantice ale vorbitorilor

Syntactic study instructions

Chestionar de limbă:

Considerând următoarele fraze, vă rog să adăugați cel puțin un cuvânt să completați propoziția.

De exemplu, considerând fraza ‘Bărbatul **a devorat**,’ posibile continuări includ:

1. Bărbatul **a devorat** o pizza.

Deasemenea, considerând fraza ‘Chelnerul **a servit**,’ posibile continuări includ:

1. Chelnerul **a servit** o supă rece.
2. Chelnerul **a servit** o supă rece femeiei.
3. Chelnerul **a servit** femeia.

Experimentul 2: elicitând intuițiile sintactice ale vorbitorilor

Transitive	Ditransitive		Allow	Require	
kiss	a săruta	give	a dărui	kill	a omorî
lick	a linge	deliver	a livra	attack	a ataca
sniff	a miroși	sell	a vinde	wash	a spăla
bite	a mușca	send	a trimite	clean	a curăța
grab	a apuca	pour	a turna	paint	a picta
pull	a trage	throw	a arunca	break	a sparge
pinch	a ciupi	bring	a aduce	lift	a ridica
hug	a îmbrățișa	tell	a povesti	open	a deschide
kick	a asalta	ask	a întreba	eat	a mânca
meet	a întâlni	buy	a cumpăra	drink	a bea
own	a posedea	promise	a promite	charm	a fermeca
believe	a crede	feed	a hrăni	defend	a apăra
say	a zice	force	a forța	defeat	a învinge
destroy	a distruge	encourage	a încuraja	calculate	a calcula
build	a construi	recommend	a recomanda	harvest	a recolta
shoot	a împușca	persuade	a convinge	watch	a privi
chase	a urmări	advise	a sfătui	administer	a administra
spill	a vărsa	lend	a împrumuta	repair	a repara
freeze	a îngheța	show	a arăta	inspect	a inspecta
Verb stimuli					
				slice	a felia
				cut	a tăia
				chop	a toca
				stab	a înjunghia
				stir	a amesteca
				hit	a lovi
				draw	a desena
				beat	a bate
				write	a scrie
				dig	a săpa
				touch	a atinge
				dissect	a diseca
				carve	a sculpta
				scratch	a zgâria
				mow	a cosi
				comb	a pieptăna
				vaccinate	a vaccina
				sweep	a mătura
				handcuff	a încătușa

C. Spanish version

Demographic questionnaire/Cuestionario demográfico

Instrucciones: Por favor conteste las preguntas que siguen a su leal saber y entender.

1. Por favor seleccione su edad:

☐ 18-22 ☐ 23-40 ☐ 41 y más

2.Sexo:

☐ Hombre ☐ Mujer

3. Por favor indica cuál es su primera lengua:

☐ Español ☐ Inglés ☐ Francés ☐ Turco ☐ Rumano

4. Cual fue **la primera lengua** hablada en su casa durante vuestra niñez?

5. Si el Español no es su primera lengua, por favor indica a que edad ha empezado aprender Español.

Semantic study instructions

Cuestionario de lengua:

Imagínense que las actividades siguientes se están pasando en una caja grande y **vacía**. ¿Qué se **necesita** (personas, objetos/cosas, lugares, etc.) estar en la caja para que las actividades tengan lugar?

Por ejemplo, dado una actividad de **devorar**, una de las respuestas posibles es:

1. alguien para devorar y algo para ser devorado (un hombre y una pizza)

Igualmente, dado una actividad de **servir**, algunas respuestas posibles son:

1. alguien que sirva y algo para servir (un camarero y una sopa fría)
2. alguien que sirva, algo para servir y alguien para ser servido (un camarero, una sopa fría y una mujer)
3. alguien que sirva y alguien para ser servido (un camarero y una mujer)

Experimento 1: explorando las intuiciones semánticas de los hablantes

Syntactic study instructions

Cuestionario de lengua:

Considerando las próximas oraciones, por favor añada al menos una palabra para **completar** la oración, sin añadir algunas informaciones innecesarias.

Por ejemplo, si presentado con la oración "El hombre *devoró*," posibles maneras de completar la oración incluyen:

1. El hombre **devoró** la pizza.

Igualmente, para la frase "El camarero sirvió," las respuestas posibles incluyen:

1. El camarero **sirvió** una sopa fría.
2. El camarero **sirvió** una sopa fría a la mujer.
3. El camarero **sirvió** la mujer.

Experimento 2: explorando las intuiciones sintácticas de los hablantes

Transitive		Ditransitive		Allow		Require	
kiss	besar	give	dar	kill	matar	slice	rebanar
lick	lamer	deliver	entregar	attack	atacar	cut	cortar
sniff	olfatear	sell	vender	wash	lavar	chop	picar
bite	morder	send	enviar	clean	limpiar	stab	apuñalar
grab	agarrar	pour	vertir	paint	pintar	stir	revolver
pull	tirar	throw	arrojar	break	romper	hit	golpear
pinch	pellizcar	bring	traer	lift	levantar	draw	dibujar
hug	abrazar	tell	contar	open	abrir	beat	vencer
kick	patear	ask	preguntar	eat	comer	write	escribir
meet	encontrar	buy	comprar	drink	beber	dig	cavar
own	poseer	promise	prometer	charm	encantar	touch	tocar
believe	creer	feed	alimentar	defend	defender	dissect	diseccionar
say	decir	force	obligar	defeat	derrotar	carve	esculpir
destroy	destruir	encourage	animar	calculate	calcular	scratch	rayar
build	construir	recommend	recomendar	harvest	cosechar	mow	segar
shoot	disparar	persuade	persuadir	watch	mirar	comb	peinar
chase	perseguir	advise	aconsejar	administer	administrar	vaccinate	vacunar
spill	derramar	lend	prestar	repair	reparar	sweep	barrer
freeze	congelar	show	mostrar	inspect	inspeccionar	handcuff	esposar

Verb stimuli

D. Turkish version

Demographic questionnaire/Demografik ve dil geçmişi anketi

Açıklamalar: Lütfen aşağıdaki soruları size en uygun şekilde cevaplayınız.

1. Lütfen yaş aralığınızı seçiniz:

☐ 18-22 ☐ 23-40 ☐ 41 ve üzeri

2. Cinsiyet:

☐ Erkek ☐ Kadın

3. Lütfen anadilinizi seçiniz:

☐ İngilizce ☐ Fransızca ☐ Türkçe ☐ Romence ☐ Diğer

4. Çocukluğunuzda evde **başlıca** konuşulan dil neydi?

5. Eğer anadiliniz Türkçe değilse, **kaç yaşında Türkçe öğrendiniz?**

Semantic study instructions

Araçlar, Türkçe Deney 1 (anlambilimsel önsezileri araştırma)

Aşağıdaki olayların tamamının **boş** bir kutuda gerçekleştiğini düşünün. Bu olayları gerçekleşebilmesi için kutunun içinde neler (kişi, nesne/eşya, mekan/yer, vb.) olması gerekmektedir?

Mesela, bir **yutma** olayı düşünün, olası cevaplar aşağıdaki gibidir:

1. yutacak biri ve yutulacak bir şey (bir adam ve bir pizza)

Aynı şekilde, bir **servis etme** olayı düşünün. Bu olay için olası cevaplar:

1. servis eden biri ve servis edilen bir şey (bir garson ve bir soğuk çorba)
2. servis eden biri, servis edilen bir şey ve servis edilen biri (bir garson, bir soğuk çorba ve bir kadın)
3. servis eden biri ve servis edilen biri (bir garson ve bir kadın)

Araştırma 1 (anlambilimsel önseziler, açıklama)

Syntactic study instructions

Araçlar, Türkçe Deney 2 (tümcebilimsel önsezi araştırması)

Lütfen verilen cümleleri en az bir kelime ekleyerek ve gereksiz bir bilgi eklemekten daha **ttamamlanmış** hale getiriniz.

Örnek olarak, **Adam yalayıp yuttu** cümlesi verilirse, olası cevaplar:

1. Adam pizzayı **yalayıp yuttu**.

Bunun gibi, mesela **Garson servis etti** cümlesinin verildiğini düşünürsek, olası cevaplar:

1. Garson soğuk bir çorba **servis etti**.
2. Garson kadına soğuk bir çorba **servis etti**.
3. Garson kadına **servis etti**.

Deney 2 (tümcebilimsel önseziler, açıklama)

Transitive - Geçişli	Ditransitive - çift Geçişli	Allow - Araca izin veren	Require - Araç isteyen
kiss	öpmek	kill	slice
lick	yalamak	attack	cut
sniff	koklamak	wash	chop
bite	sokmak	clean	stab
grab	kapmak	paint	stir
pull	çekmek	break	hit
pinch	çimdiklemek	lift	draw
hug	sarılmak	open	beat
kick	tekmelemek	eat	write
meet	buluşmak	drink	dig
own	sahip olmak	charm	touch
believe	inanmak	defend	dissect
say	söylemek	defeat	carve
destroy	tahrip etmek	calculate	scratch
build	inşa etmek	harvest	mow
shoot	ateş etmek	watch	comb
chase	kovalamak	administer	vaccinate
spill	dökmek	repair	sweep
freeze	dondurmak	inspect	handcuff
Verb stimuli			
		öldürmek	dilimlemek
		saldırmak	kesmek
		ylkamak	dögramak
		temizlemek	saplamak
		boyamak	kariştirmek
		kırmak	vurmak
		kaldırmak	çizmek
		açmak	yenmek
		yemek	yazmak
		içmek	kazmak
		etkilemek	dokunmak
		savunmak	incelemek
		yenmek	oymak
		hesaplamak	kaşımak
		hasat etmek	biçmek
		izlemek	taramak
		yönetmek	aşılacak
		tamir etmek	stüpürmek
		incelemek	kelepçelemek

E. Cross-linguistic ditransitivity

	English		Spanish		Romanian		Turkish	
verb	sem	syn	sem	syn	sem	syn	sem	syn
advise	23.91	37.18	20.40	1.96	10.71	24.64	23.64	12.00
ask	34.04	20.51	39.22	1.96	25.42	16.67	23.64	22.00
bring	41.82	19.23	17.65	1.96	31.58	3.67	20.00	6.00
buy	34.04	0.00	25.49	0.00	50.00	0.00	27.27	4.00
deliver	23.73	2.60	49.02	5.88	37.29	7.27	33.33	22.00
encourage	22.50	40.26	12.00	39.22	12.28	16.37	13.21	22.00
feed	51.67	11.69	42.86	1.96	54.39	0.00	41.82	8.00
force	28.57	80.26	52.94	54.00	11.11	0.00	10.91	12.00
give	41.67	68.06	66.67	30.00	54.24	38.18	25.93	22.00
lend	50.91	51.95	68.63	14.00	62.10	10.91	34.55	18.00
persuade	31.58	46.67	26.00	8.00	18.18	30.91	21.82	20.00
pour	32.14	11.54	78.43	42.86	53.93	38.18	22.22	30.00
promise	36.73	15.58	56.86	3.92	31.58	5.45	18.52	8.00
recommend	35.29	10.26	56.86	2.00	42.11	3.67	26.42	6.00
sell	44.23	6.41	39.22	0.00	55.93	5.45	38.89	10.00
send	33.33	35.90	54.00	13.73	45.76	16.37	27.27	30.00
show	43.48	38.96	49.02	11.76	50.00	7.27	23.64	10.00
tell	39.62	36.36	33.33	2.04	35.71	9.09	12.73	28.00
throw	13.56	35.48	21.57	24.00	32.76	12.96	14.55	30.00

Mentions of direct and indirect objects proportions

F. Sample language production across groups (ASD, LAD, and TD)

Examples of verbs coded as *other* by group

TD

- and then um the monkey, the other monkey, who was walking by and relaxing under the tree which was the coconut tree the monkey was hiding in.

HFA

- huh how do coconuts fall out of the sky?

OO

- So uh the first scene is you know a monkey sitting in a tree
- I'm going to take it off and gather it into my you know little cabana or whatever
- does the story have to be exactly correct?
- so that when he climbs down he just grab them or eat them or take them back to his ho- to you know where he lives or something
- wait did I say coconut? I'll just start over. One day there was a monkey climbing up a palm tree.

Errors related to argument structure by group

HFA

- the monkey in the tree throws a coconut *on the that monkey's head*.
- the monkey standing at the bottom *see it*
- the other monkey *run, runs* back to get it
- then when he *reaches* it, the other monkey dropped a coconut on his head
- another one *had droppen*
- then there's another monkey sitting under a tree, *picks* up the coconut, *starts* walking away
- after he climbed down, *he set the he set another coconut fell*
- he picked *his the new coconut up*
- he dropped the coconut *to his the monkey*
- but then there was a monkey sitting at the bottom of the tree and *saw* the coconut fall out of the tree
- bonk, *hits* him on the head with a coconut
- the monkey threw the coconut *on near the monkey's head*
- I'll drop it *on in*
- and then the *coconuts falls* down
- *got bonked* on the head with a coconut

OO

- His brother sitting at the bottom of the tree *hasn't*
- the younger brother *notice, noticed* him
- he drops another coconut *on the first the monkey* that was at the bottom of the tree that stole his coconut on his head
- and he's dropping them onto the ground *so that*. he's going to drop them onto the ground
- so that when he climbs down he just *grab* them or *eat them* or *take them* back
- the monkey *is pick picking up* coconuts *from a climbing a tree* and picking coconuts
- so a monkey down at the bottom of the palm tree waiting for it.
- A monkey is gathering coconuts *trimming the tree*

TD

- he sees the coconut *falls fall*
- and then um the monkey, the other monkey, who was walking by and relaxing under the tree which was the coconut tree the monkey was hiding in
- the monkey in the tree whose collecting coconuts is unhappy with this, *wonders* why the other one ran away with it
- The first monkey *had was picking* some coconuts

Bibliography

- Achenbach, T. M. (1987). What is “developmental” about Developmental Psychopathology? In *Society for Research in Child Development*.
- Almon, B. (1996). *Mind the Gap*. Ekstasis Editions Canada Ltd.
- Ambridge, B., Bannard, C., and Jackson, G. H. (2015). Is grammar spared in autism spectrum disorder? Data from judgments of verb argument structure overgeneralization errors. *Journal of autism and developmental disorders*, 45(10):3288–3296.
- Apresjan, Y. D. (1992). *Lexical Semantics: User’s Guide To Contemporary Russian Vocabulary*. Karoma Pub.
- Asudeh, A. and Giorgolo, G. (2012). Flexible composition for optional and derived arguments. In *Proceedings of the LFG12 Conference*, pages 64–84.
- Barbieri, E., Basso, A., Frustaci, M., and Luzzatti, C. (2010). Argument structure deficits in aphasia: New perspective on models of lexical production. *Aphasiology*, 24(11):1400–1423.
- Barbieri, E., Brambilla, I., Thompson, C. K., and Luzzatti, C. (2019). Verb and sentence processing patterns in healthy italian participants: Insight from the north-

- western assessment of verbs and sentences (navs). *Journal of communication disorders*, 79:58–75.
- Barbu, R.-M. (2015). Verbs and participants: Non-linguists’ intuitions. *Unpublished master’s thesis, Carleton University*.
- Barbu, R.-M. and Toivonen, I. (2016a). Arguments and Adjuncts: at the Syntax-Semantics Interface. *Florida Linguistics Papers*, 3(1).
- Barbu, R.-M. and Toivonen, I. (2016b). Event participants and linguistic arguments. In *Proceedings of the 38th Annual Meeting of the Cognitive Science Society*.
- Bartolucci, G. and Albers, R. J. (1974). Deictic categories in the language of autistic children. *Journal of Autism and Childhood Schizophrenia*, 4(2):131–141.
- Beeke, S., Wilkinson, R., and Maxim, J. (2007). Individual variation in agrammatism: A single case study of the influence of interaction. *International Journal of Language & Communication Disorders*, 42(6):629–647.
- Ben-Shachar, M., Hendler, T., Kahn, I., Ben-Bashat, D., and Grodzinsky, Y. (2003). The neural reality of syntactic transformations: Evidence from functional magnetic resonance imaging. *Psychological science*, 14(5):433–440.
- Bird, S., Klein, E., and Loper, E. (2009). *Natural language processing with Python: analyzing text with the natural language toolkit*. O’Reilly Media, Inc.
- Blodgett, A. and Boland, J. E. (2004). Differences in the timing of implausibility detection for recipient and instrument prepositional phrases. *Journal of psycholinguistic research*, 33(1):1–24.

- Boas, H. C. (2013). Cognitive Construction Grammar. In *The Oxford handbook of construction grammar*. Oxford University Press.
- Boland, J. (2017). Twenty-first century psycholinguistics: Four cornerstone. In Cutler, A., editor, *Cognitive mechanisms and syntactic theory*, pages 1–20. Routledge.
- Boland, J. E. (2005). Visual arguments. *Cognition*, 95(3):237–274.
- Boland, J. E. and Blodgett, A. (2006). Argument status and PP-attachment. *Journal of Psycholinguistic Research*, 35(5):385–403.
- Bowerman, M. and Brown, P. (2008). *Crosslinguistic perspectives on argument structure*. Taylor & Francis.
- Bresnan, J. (1982). *The mental representation of grammatical relations*. MIT Press.
- Bresnan, J. (1995). Lexicality and argument structure. In *Paris Syntax and Semantics Conference*, volume 12.
- Bresnan, J., Asudeh, A., Toivonen, I., and Wechsler, S. (2016). *Lexical Functional Syntax*. John Wiley & Sons.
- Brouwer, H., Crocker, M. W., Venhuizen, N. J., and Hoeks, J. C. (2017). A neurocomputational model of the N400 and the P600 in language processing. *Cognitive science*, 41:1318–1352.
- Brouwer, H., Fitz, H., and Hoeks, J. (2012). Getting real about semantic illusions: rethinking the functional role of the P600 in language comprehension. *Brain research*, 1446:127–143.
- Burns, N. (2012). *The Book of Eleanor*. Bella Books Inc.

- Caley, S., Whitworth, A., and Claessen, M. (2017). Can we separate verbs from their argument structure? a group study in aphasia. *International Journal of Language & Communication Disorders*, 52(1):59–70.
- Canfield, A. R., Eigsti, I.-M., de Marchena, A., and Fein, D. (2016). Story goodness in adolescents with autism spectrum disorder (ASD) and in optimal outcomes from ASD. *Journal of Speech, Language, and Hearing Research*, 59(3):533–545.
- Chomsky, N. (1981). *Lectures on Government and Binding*. Foris Publications.
- Chomsky, N. (2014). *The minimalist program*. The MIT Press.
- Cicchetti, D. (1984). The emergence of developmental psychopathology. *Child development*, pages 1–7.
- Cicchetti, D. (1993). Developmental psychopathology: Reactions, reflections, projections. *Developmental review*, 13(4):471–502.
- Cicchetti, D. (1996). *Developmental pathways: Diversity in process and outcome*. Cambridge University Press.
- Cicchetti, D. and Rogosch, F. A. (1996). Equifinality and multifinality in developmental psychopathology. *Development and psychopathology*, 8(4):597–600.
- Cinque, G. (1999). *Adverbs and functional heads: A cross-linguistic perspective*. Oxford University Press on Demand.
- Cinque, G. (2004). Issues in adverbial syntax. *Lingua*, 114(6):683–710.

- Costello, E. J. and Maughan, B. (2015). Annual research review: optimal outcomes of child and adolescent mental illness. *Journal of Child Psychology and Psychiatry*, 56(3):324–341.
- Coulson, S., King, J. W., and Kutas, M. (1998). Expect the unexpected: Event-related brain response to morphosyntactic violations. *Language and cognitive processes*, 13(1):21–58.
- Creissels, D. (2007). A sketch of bambara argument structure. In *Workshop Grammar and Processing of Verbal Arguments. Leipzig*.
- Croft, W. (1991). *Syntactic categories and grammatical relations: The cognitive organization of information*. University of Chicago Press.
- Croft, W. and Croft, W. A. (2001). *Radical construction grammar: Syntactic theory in typological perspective*. Oxford University Press on Demand.
- Croft, W. and Cruse, D. A. (2004). *Cognitive linguistics*. Cambridge University Press.
- Cuervo, M. C. (2010). Against ditransitivity. *Probus*, 22(2):151–180.
- Dalrymple, M. (2001). *Lexical functional grammar*. Brill.
- Dalrymple, M. and Mycock, L. (2019). *The Oxford Reference Guide to Lexical Functional Grammar*. Oxford University Press, USA.
- DeDe, G. (2013). Effects of verb bias and syntactic ambiguity on reading in people with aphasia. *Aphasiology*, 27(12):1408–1425.

- Deliens, G., Papastamou, F., Ruytenbeek, N., Geelhand, P., and Kissine, M. (2018). Selective pragmatic impairment in autism spectrum disorder: Indirect requests versus irony. *Journal of Autism and Developmental Disorders*, 48(9):2938–2952.
- den Ouden, D.-B., Fix, S., Parrish, T. B., and Thompson, C. K. (2009). Argument structure effects in action verb naming in static and dynamic conditions. *Journal of Neurolinguistics*, 22(2):196–215.
- Denham, K. and Lobeck, A. (2012). *Linguistics for everyone: An introduction*. Cengage Learning.
- Di Giovanni, D. A. (2016). *Neural & Predictive Effects of Verb Argument Structure*. PhD thesis, Carleton University.
- Donohue, C., Donohue, M., Butt, M., and King, T. H. (2004). On the special status of instrumentals. In *Proceedings of the LFG04 Conference, On-line proceedings*. Stanford, CA: CSLI Publications.
- Dosher, B. A. and Corbett, A. T. (1982). Instrument inferences and verb schemata. *Memory & Cognition*, 10(6):531–539.
- Dowty, D. (1982). Grammatical relations and Montague grammar. In *The nature of syntactic representation*, pages 79–130. Springer.
- Dowty, D. (2003). The dual analysis of adjuncts/complements in categorical grammar. *Modifying adjuncts*, 33.
- Eigsti, I.-M. and Bennetto, L. (2009). Grammaticality judgments in autism: Deviance or delay. *Journal of Child Language*, 36(5):999–1021.

- Eigsti, I.-M., Bennetto, L., and Dadlani, M. B. (2007). Beyond pragmatics: Morphosyntactic development in autism. *Journal of Autism and Developmental Disorders*, 37(6):1007–1023.
- Eigsti, I.-M., de Marchena, A. B., Schuh, J. M., and Kelley, E. (2011). Language acquisition in autism spectrum disorders: A developmental review. *Research in Autism Spectrum Disorders*, 5(2):681–691.
- Eigsti, I.-M. and Fein, D. A. (2013). More is less: pitch discrimination and language delays in children with optimal outcomes from autism. *Autism Research*, 6(6):605–613.
- Fein, D., Barton, M., Eigsti, I.-M., Kelley, E., Naigles, L., Schultz, R. T., Stevens, M., Helt, M., Orinstein, A., Rosenthal, M., et al. (2013). Optimal outcome in individuals with a history of autism. *Journal of Child Psychology and Psychiatry*, 54(2):195–205.
- Friederici, A. D. and Frisch, S. (2000). Verb argument structure processing: The role of verb-specific and argument-specific information. *Journal of Memory and language*, 43(3):476–507.
- Friederici, A. D. and Meyer, M. (2004). The brain knows the difference: Two types of grammatical violations. *Brain research*, 1000(1-2):72–77.
- Frisch, S., Hahne, A., and Friederici, A. D. (2004). Word category and verb–argument structure information in the dynamics of parsing. *Cognition*, 91(3):191–219.
- Frisch, S. and Schleewsky, M. (2001). The N400 reflects problems of thematic hierarchizing. *NeuroReport*, 12(15):3391–3394.

- Garnezy, N. (1992). *Risk and protective factors in the development of psychopathology*. Cambridge University Press.
- Geeraerts, D. and Cuyckens, H. (2007). *The Oxford handbook of cognitive linguistics*. Oxford University Press.
- Georgiades, S. and Kasari, C. (2018). Reframing optimal outcomes in autism. *JAMA pediatrics*, 172(8):716–717.
- Gheorghiu, C. I. (2009). Is similarity between two working languages a decision-making factor for the trainee-interpreter? the case of romanian and spanish. *Limbi și LLiteraturi Străine*, page 151.
- Gleitman, L. (1990). The structural sources of verb meanings. *Language acquisition*, 1(1):3–55.
- Goddard, C., Wierzbicka, A., and Wong, J. (2016). “walking” and “running” in english and german: The conceptual semantics of verbs of human locomotion. *Review of Cognitive Linguistics. Published under the auspices of the Spanish Cognitive Linguistics Association*, 14(2):303–336.
- Goldberg, A. E. (1995). *Constructions: A construction grammar approach to argument structure*. University of Chicago Press.
- Goldberg, A. E. (2002). Surface generalizations: An alternative to alternations. *Cognitive Linguistics*, 13(4):327–356.
- Goldberg, A. E. (2006). *Constructions at work: The nature of generalization in language*. Oxford University Press on Demand.

- Grela, B. G. (2003). Do children with down syndrome have difficulty with argument structure? *Journal of Communication Disorders*, 36(4):263–279.
- Grimshaw, J. (1990). *Argument structure*. the MIT Press.
- Haegeman, L. (1994). *Introduction to Government and Binding Theory*. Blackwell, Oxford.
- Hammett, L. A., Kleeck, A., and Huberty, C. J. (2003). Patterns of parents’ extratextual interactions during book sharing with preschool children: A cluster analysis study. *Reading Research Quarterly*, 38(4):442–468.
- Hernández, M., Fairhall, S. L., Lenci, A., Baroni, M., and Caramazza, A. (2014). Predication drives verb cortical signatures. *Journal of cognitive neuroscience*, 26(8):1829–1839.
- Hewamanne, S. (2011). *Stitching identities in a free trade zone: Gender and politics in Sri Lanka*. University of Pennsylvania Press.
- Hornstein, N. and Nunes, J. (2008). Adjunction, labeling, and bare phrase structure. *Biolinguistics*, 2(1):057–086.
- Hornstein, N., Nunes, J., and Grohmann, K. K. (2005). *Understanding minimalism*. Cambridge University Press.
- Horvath, S., McDermott, E., Reilly, K., and Arunachalam, S. (2018). Acquisition of verb meaning from syntactic distribution in preschoolers with autism spectrum disorder. *Language, Speech, and Hearing Services in Schools*, 49(3S):668–680.

- Hwang, J. D. (2012). Making verb argument adjunct distinctions in English. *Colorado Research in Linguistics*, 23.
- Irvine, C. A., Eigsti, I.-M., and Fein, D. A. (2016). Uh, um, and autism: filler disfluencies as pragmatic markers in adolescents with optimal outcomes from autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 46(3):1061–1070.
- Jackendoff, R. (1987). The status of thematic relations in linguistic theory. *Linguistic inquiry*, 18(3):369–411.
- Jackendoff, R. (2002). *Foundations of language: Brain, meaning, grammar, evolution*. Oxford University Press.
- Jackendoff, R. (2010). *Meaning and the lexicon: the parallel architecture 1975-2010*. OUP Oxford.
- Kak, S. C. (1987). The paninian approach to natural language processing. *International Journal of Approximate Reasoning*, 1(1):117–130.
- Kaplan, R. M. and Bresnan, J. (1995). Formal System for Grammatical Representation. In Dalrymple, M., Kaplan, R. M., Maxwell III, J. T., and Zaenen, A. E., editors, *Formal Issues in Lexical-Functional Grammar*. Center for the Study of Language (CSLI).
- Kaplan, R. M., Bresnan, J., et al. (1982). Lexical-functional grammar: A formal system for grammatical representation. *Formal Issues in Lexical-Functional Grammar*, 47:29–130.

- Kay, P. (2005). Argument structure constructions and the argument-adjunct distinction. *Grammatical constructions: Back to the roots*, 4:71–98.
- Kay, P. and Fillmore, C. J. (1999). Grammatical constructions and linguistic generalizations: the what’s x doing y? construction. *Language*, 75(1):1–33.
- Kearns, K. (2011). *Semantics*. Palgrave Modern Linguistics.
- Kegl, J. and Poizner, H. (1997). Crosslinguistic/crossmodal syntactic consequences of left-hemisphere damage: evidence from an aphasic signer and his identical twin. *Aphasiology*, 11(1):1–37.
- Kim, M. and Thompson, C. K. (2000). Patterns of comprehension and production of nouns and verbs in agrammatism: Implications for lexical organization. *Brain and language*, 74(1):1–25.
- Kim, M. and Thompson, C. K. (2004). Verb deficits in Alzheimer’s disease and agrammatism: Implications for lexical organization. *Brain and language*, 88(1):1–20.
- Koenig, J.-P., Mauner, G., and Bienvenue, B. (2002). Class specificity and the lexical encoding of participant information. *Brain and language*, 81(1-3):224–235.
- Koenig, J.-P., Mauner, G., and Bienvenue, B. (2003). Arguments for adjuncts. *Cognition*, 89(2):67–103.
- Koenig, J.-P., Mauner, G., Bienvenue, B., and Conklin, K. (2008). What with? the anatomy of a (proto)-role. *Journal of Semantics*, 25(2):175–220.

- Kohen, F., Milsark, G., and Martin, N. (2011). Effects of syntactic and semantic argument structure on sentence repetition in agrammatism: Things we can learn from particles and prepositions. *Aphasiology*, 25(6-7):736–747.
- Kroeger, P. R. (2005). *Analyzing grammar: An introduction*. Cambridge University Press.
- Kudrnáčová, N. (2019). Contrastive semantics of human locomotion verbs: English walk vs. czech jít and kráčet. *Review of Cognitive Linguistics. Published under the auspices of the Spanish Cognitive Linguistics Association*, 17(1):53–77.
- Kutas, M. and Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science*, 207(4427):203–205.
- Lakoff, G. (1968). Instrumental adverbs and the concept of deep structure. *Foundations of language*, pages 4–29.
- Lakoff, G. and Ross, J. R. (1976). Why you can't do so into the sink. In *Notes from the linguistic underground*, pages 101–111. Brill.
- Lee, D., Pruce, B., and Newman, S. D. (2014). The neural bases of argument structure processing revealed by primed lexical decision. *cortex*, 57:198–211.
- Lee, J. and Thompson, C. K. (2011). Real-time production of arguments and adjuncts in normal and agrammatic speakers. *Language and cognitive processes*, 26(8):985–1021.
- Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., DiLavore, P. C., Pickles, A., and Rutter, M. (2000). The Autism Diagnostic Observation Sched-

- ule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of autism and developmental disorders*, 30(3):205–223.
- Lord, C., Rutter, M., DiLavore, P. C., and Risi, S. (2002). *Autism diagnostic observation schedule: ADOS*. Western Psychological Services Los Angeles, CA.
- MacQueen, J. (1967). Some methods for classification and analysis of multivariate observations. In *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability, Volume 1: Statistics*, pages 281–297, Berkeley, Calif. University of California Press.
- Maess, B., Mamashli, F., Obleser, J., Helle, L., and Friederici, A. D. (2016). Prediction signatures in the brain: semantic pre-activation during language comprehension. *Frontiers in human neuroscience*, 10:591.
- Malchukov, A., Haspelmath, M., and Comrie, B. (2010). *Studies in ditransitive constructions: A comparative handbook*. Walter de Gruyter.
- Malyutina, S. (2015). *Neural Correlates of Verb Argument Structure Processing*. PhD thesis, University of South Carolina.
- Malyutina, S. and den Ouden, D.-B. (2017). Task-dependent neural and behavioral effects of verb argument structure features. *Brain and language*, 168:57–72.
- Meltzer-Asscher, A., Mack, J. E., Barbieri, E., and Thompson, C. K. (2015). How the brain processes different dimensions of argument structure complexity: Evidence from fmri. *Brain and language*, 142:65–75.

- Meltzer-Asscher, A., Schuchard, J., den Ouden, D.-B., and Thompson, C. K. (2013). The neural substrates of complex argument structure representations: Processing “alternating transitivity” verbs. *Language and cognitive processes*, 28(8):1154–1168.
- Michael, S. E., Ratner, N. B., and Newman, R. (2012). Verb comprehension and use in children and adults with down syndrome. *Journal of Speech, Language, and Hearing Research*, 55(6):1736–1749.
- Moura, H. and Miliorini, R. (2018). Toward a comprehension of an intuition: Criteria for distinguishing verbal arguments and adjuncts. *Alfa: Revista de Linguística (São José do Rio Preto)*, 62(3):573–589.
- Needham, S. and Toivonen, I. (2011). Derived arguments. In *Proceedings of the LFG11 Conference*, pages 401–421.
- Nemoto, N. (2012). Locative Alternation: A Lexical-Constructional Approach. *English Linguistics*, 29(1):166–175.
- Nilsen, D. L. (2019). *The instrumental case in English: Syntactic and semantic considerations*. Walter de Gruyter GmbH & Co KG.
- Nilsen, D. L. F. (1973). *The instrumental case in English: Syntactic and semantic considerations*. Mouton.
- Ntelitheos, D. (2012). *Deriving nominals: A syntactic account of Malagasy nominalizations*, volume 3. Brill.
- O’Dwyer, B. (2006). *Modern English Structures-: Form, Function, and Position*. Broadview Press.

- Pierce, S. and Bartolucci, G. (1977). A syntactic investigation of verbal autistic, mentally retarded, and normal children. *Journal of Autism and Childhood Schizophrenia*, 7(2):121–134.
- Pollard, C. and Sag, I. A. (1994). *Head-driven phrase structure grammar*. University of Chicago Press.
- Prior, M. R. and Hall, L. C. (1979). Comprehension of transitive and intransitive phrases by autistic, retarded, and normal children. *Journal of Communication Disorders*, 12(2):103–111.
- Rákosi, G. (2013). Down with obliques? *Tracy Holloway King & Valeria de Paiva szerk (eds), From Quirky Case to Representing Space: Papers in Honor of Annie Zaenen*, pages 127–138.
- Rapin, I. and Dunn, M. (2003). Update on the language disorders of individuals on the autistic spectrum. *Brain and Development*, 25(3):166–172.
- Rissman, L. (2010). Instrumental with, locatum with and the argument/adjunct distinction. In *LSA Annual Meeting Extended Abstracts*, volume 1, pages 23–1.
- Rissman, L. (2013). *Event participant representations and the instrumental role: A cross-linguistic study*. The Johns Hopkins University.
- Rissman, L., Rawlins, K., and Landau, B. (2015). Using instruments to understand argument structure: Evidence for gradient representation. *Cognition*, 142:266–290.
- Roberts, I. (2017). *The Oxford Handbook of Universal Grammar*. Oxford University Press.

- Roberts, J. A., Rice, M. L., and Tager-Flusberg, H. (2004). Tense marking in children with autism. *Applied Psycholinguistics*, 25(3):429–448.
- Rösler, F., Pütz, P., Friederici, A., and Hahne, A. (1993). Event-related brain potentials while encountering semantic and syntactic constraint violations. *Journal of cognitive neuroscience*, 5(3):345–362.
- Sag, I. A., Wasow, T., and Bender, E. (2003). *Syntactic Theory: A formal introduction (2nd edition)*. Stanford: CSLI Publications.
- Sassenhagen, J., Blything, R., Lieven, E., and Ambridge, B. (2018). Frequency Sensitivity of Neural Responses to English Verb Argument Structure Violations. *Colabra: Psychology*, 4(1).
- Schäfer, F. (2009). The causative alternation. *Language and linguistics compass*, 3(2):641–681.
- Schlesinger, I. M. (2006). *Cognitive space and linguistic case: Semantic and syntactic categories in English*. Cambridge University Press.
- Schütze, C. T. (1995). Pp attachment and argumenthood. *MIT working papers in linguistics*, 26(95):151.
- Sedivy, J. and Spivey-Knowlton, M. (1994). 16 The use of structural, lexical, and pragmatic information in parsing attachment ambiguities. *Perspectives on sentence processing*, page 26.
- Semel, E., Wiig, E., and Secord, W. (2003). The Clinical Evaluation of Language Fundamentals - (Australian Standardisation). St Peters.

- Sharpe, V., Reddigari, S., Pykkänen, L., and Marantz, A. (2019). Automatic access to verb continuations on the lexical and categorical levels: evidence from meg. *Language, Cognition and Neuroscience*, 34(2):137–150.
- Shetreet, E., Friedmann, N., and Hadar, U. (2010). Cortical representation of verbs with optional complements: The theoretical contribution of fmri. *Human brain mapping*, 31(5):770–785.
- Shetreet, E., Palti, D., Friedmann, N., and Hadar, U. (2006). Cortical representation of verb processing in sentence comprehension: Number of complements, subcategorization, and thematic frames. *Cerebral Cortex*, 17(8):1958–1969.
- Song, Y., Jia, Z., Liu, S., and Liang, D. (2017). Discourse production of mandarin-speaking children with high-functioning autism: The effect of mental and action verbs’ semantic-pragmatic features. *Journal of Communication Disorders*, 70:12–24.
- Speece, D. L. (1990). Methodological issues in cluster analysis: How clusters become real. *Learning disabilities: Theoretical and research issues*, pages 201–213.
- Spivey-Knowlton, M. and Sedivy, J. C. (1995). Resolving attachment ambiguities with multiple constraints. *Cognition*, 55(3):227–267.
- Staal, J. F. and Staal, F. (1972). *A reader on the Sanskrit grammarians*. MIT Press.
- Stockbridge, M. D., Happé, F. G., and White, S. J. (2014). Impaired comprehension of alternating syntactic constructions in autism. *Autism Research*, 7(3):314–321.
- Tager-Flusberg, H. (1981). On the nature of linguistic functioning in early infantile autism. *Journal of Autism and Developmental Disorders*, 11(1):45–56.

- Tager-Flusberg, H., Calkins, S., Nolin, T., Baumberger, T., Anderson, M., and Chadwick-Dias, A. (1990). A longitudinal study of language acquisition in autistic and Down syndrome children. *Journal of Autism and Developmental Disorders*, 20(1):1–21.
- Tallerman, M. (2014). *Understanding syntax*. Routledge.
- Tesnière, L. (1959). *Eléments de syntaxe structurale*. Librairie C. Klincksieck.
- Thompson, C. K., Bonakdarpour, B., Fix, S. C., Blumenfeld, H. K., Parrish, T. B., Gitelman, D. R., and Mesulam, M.-M. (2007). Neural correlates of verb argument structure processing. *Journal of Cognitive Neuroscience*, 19(11):1753–1767.
- Thompson, C. K., Bonakdarpour, B., and Fix, S. F. (2010). Neural mechanisms of verb argument structure processing in agrammatic aphasic and healthy age-matched listeners. *Journal of Cognitive Neuroscience*, 22(9):1993–2011.
- Thompson, C. K. and Meltzer-Asscher, A. (2014). Neurocognitive mechanisms of verb argument structure processing. *Structuring the argument*, pages 141–168.
- Toivonen, I. (2012). Between arguments and adjuncts. In *International conference of Nordic and General Linguistics. Freiburg, Germany*.
- Toivonen, I. (2013). English benefactive nps. In *Proceedings of the LFG 2013 conference*, pages 503–523.
- Traxler, M. J. (2011). *Introduction to psycholinguistics: Understanding language science*. John Wiley & Sons.

- Troyb, E., Rosenthal, M., Eigsti, I.-M., Kelley, E., Tyson, K., Orinstein, A., Barton, M., and Fein, D. (2014). Executive functioning in individuals with a history of ASDs who have achieved optimal outcomes. *Child Neuropsychology*, 20(4):378–397.
- Türker, L. (2019). *Noun phrases in article-less languages: Uzbek and beyond*, volume 253. John Benjamins Publishing Company.
- Tutunjian, D. and Boland, J. E. (2008). Do we need a distinction between arguments and adjuncts? Evidence from psycholinguistic studies of comprehension. *Language and Linguistics Compass*, 2(4):631–646.
- Ungerer, F. and Schmid, H.-J. (2013). *An introduction to cognitive linguistics*. Routledge.
- Van Luven, K. (2014). The argument status of directional PPs. *Undergraduate honors thesis, Carleton University*.
- Van Valin Jr, R. D. and LaPolla, R. J. (1997). *Syntax: Structure, meaning, and function*. Cambridge University Press.
- Vater, H. (1978). On the possibility of distinguishing between complements and adjuncts. *Valence, semantic case and grammatical relations*, 1:21–45.
- Wang, X., Hang, M., and Liang, D. (2019). The cognitive neural mechanisms of verb argument structure complexity processing. *Advances in Psychological Science*, 28(1):62–74.
- Webb, J. (2008). *Instruments in LFG’s Argument-structure*. PhD thesis, Oxford University, UK.

- Whitworth, A., Webster, J., and Howard, D. (2015). Argument structure deficit in aphasia: it's not all about verbs. *Aphasiology*, 29(12):1426–1447.
- Ye, Z. et al. (2010). Eating and drinking in mandarin and shanghainese: A lexical-conceptual analysis. In *ASCS09: Proceedings of the 9th Conference of the Australasian Society for Cognitive Science*, pages 375–383. Macquarie Centre for Cognitive Science Sydney.
- Zaenen, A. and Crouch, D. (2009). Obls hobble computations. *Proceedings of LFG09*, pages 644–654.
- Zahedi, K. (2012). Body parts in language: A cognitive semiosis of human mind. *Procedia-Social and Behavioral Sciences*, 32:334–338.
- Zhou, P., Zhan, L., and Ma, H. (2019). Predictive Language Processing in Preschool Children with Autism Spectrum Disorder: An Eye-Tracking Study. *Journal of Psycholinguistic Research*, 48(2):431–452.