Adult passive representations in English and Balinese: crosslinguistic evidence for semantic and context effects from priming and acceptability judgment studies

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy by I Made Sena Darmasetiyawan

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Abstract

The question of the nature of speakers' linguistic representations has been explained by accounts that fall into two different theoretical camps: generativist (i.e., formalist or Universal Grammar) and constructivist (i.e., semantics-based or usage-based). While generativist accounts propose that speakers possess innate knowledge that governs and constrains formal syntactic rules in language acquisition and use (e.g., Chomsky, 1981; Newmeyer. 2003), constructivist accounts emphasize accumulative experience of input that forms language structures (e.g., Croft & Cruse, 2004; Langacker, 2008). The overall aim of this thesis is to test the predictions of these competing accounts with respect to the passive construction, across two languages: English and Balinese.

Chapter 1 sets out the general properties of different individual accounts that fall under the generativist and constructivist approaches, and presents some evidence with respect to these accounts in relation to language representation (including some studies with children).

Chapter 2 sets out the detailed proposals from generativist and constructivist approaches with reference to the passive construction in particular. Although the focus is again on the nature of adults' representations, child studies are also included, since they bear on the question on the formation of these representations.

Study 1 in Chapter 3 test these accounts by replicating Messenger, Branigan, McLean & Sorace's (2012) Study 2 – a passive priming study – in a sufficiently powered sample of adults (*N=240*). This study is replicated to test both generativist and constructivist claims with regard to the passive. The original study, while underpowered, found that *theme-experiencer* (e.g., *frighten*) and *experiencer-theme verbs* (e.g., *ignore*) appear to be equally effective at priming *agent-patient* passives (e.g., *The witch was hugged by the cat*). That is "the magnitude of priming was unaffected by verb type" (Messenger et al, 2012) – no semantic effect was found. This previous study therefore constitutes evidence against constructivist accounts, which assume the passive construction has its own meaning ("affectedness"). In (partial) contrast, the present study found only weak semantic effects in priming; though (in a Bayesian analysis) it certainly did not find positive evidence *against* semantic effects.

Study 2 in Chapter 4 reports a grammatical acceptability judgment conducted in Balinese, following other crosslinguistic studies of the passive in Indonesian (Aryawibawa & Ambridge, 2018) and Mandarin (Liu & Ambridge, 2020). This study found a significant effect of semantics (i.e., affectedness), and extends previous crosslinguistic investigations across the four different passive types found in Balinese. Thus, this study provides support for the prediction of the constructivist approach with regard to construction semantics.

Study 3 in Chapter 5 tests for construction-semantic effects in a new way, by manipulating affectedness not by changing the verb but by changing the context (high and low affectedness) while holding the verb (and indeed the whole sentence) constant. The result showed that although relatively small (due to the use of only grammatically acceptable sentences), the context effect is statistically significant, again providing support for the constructivist account.

Chapter 6 summarizes all the findings from Study 1-3 and their theoretical and practical implication, as well as providing some suggestions of possible future studies. Even though the findings of this thesis broadly support the constructivist view, it does not of course provide a resolution to the long-running debate between generativist and constructivist claims. It does, however, demonstrate evidence of both semantic and (to some extent) non-linguistic contextual factors; findings that will hopefully prove informative to the ongoing theoretical debate between these approaches.

Declaration

I declare that no portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning

Copyright Statement

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Special thanks go to my family members; my wife Anny, my daughter Kirana, and my son Baskara, who gave endless encouragement and moral support even when we were half the world apart. Finally, I would like to thank all the students from both the University of Liverpool and Universitas Udayana who gave up their time to participate in my adult studies.

Rationale for submitting thesis in an alternative format

This thesis has been submitted in the Alternative Paper Format, which consists of experimental chapters that are in a format suitable for submission for publication in a peer-reviewed scientific journal (indeed, two of the three empirical chapters have already been published as journal articles). However, the formatting of these papers has been matched to the overall formatting of the thesis for consistency. For instance, no reference section is provided after each paper; all references are listed together at the end of the thesis. In all other respects, the chapters have been formatted in a manner that is suitable for submission for publication. This alternative format does not differ from the standards that are expected for a traditional thesis.

Since the experiments are written as independent publishable papers, each paper is preceded by a short section that contextualizes each study within the wider theoretical and empirical context and debate in the literature, to maintain the coherence and the flow of the thesis as a whole.

The thesis begins with general introductory chapters that review the background of the research (Chapters 1 and 2) and concludes with a general discussion that summarises and discusses the overall outcomes of the research and how they fit into the wider context (Chapter 6). The experiments that have been conducted are presented as a series of three papers. As of the thesis submission date, two papers have been published (Chapter 3 and 4), both in *Collabra: Psychology*, and one paper is in preparation for submission (Chapter 5).

The supervisors for my Ph.D. program, Dr. Perrine Brusini and Prof. Julian Pine – as well as my former supervisor, Professor Ben Ambridge – who moved to the University of Manchester around 6 months before the submission of this thesis – have provided helpful advice and comments on thesis drafts. In addition to researching the literature and the research questions for each experimental paper, I have been responsible (with help and support from Prof Ambridge) for the design of the studies including their procedure and materials (videos, pictures, audio recordings, etc.), recruiting, piloting and testing participants, coding and analysing the data, writing the papers, submitting them to the journals, and corresponding with the journals regarding revisions.

The reason for adopting this alternative thesis format is my wish to share my research findings with a wider community. Submitting and publishing studies in international peer-reviewed journals can also improve the quality of research output since it must meet the high standards of the chosen journals through the peer review process. Publication also opens up the findings to potential criticism and evaluation from the wider research community, allowing me to contribute in a small way to the vast empirical literature on adult language representation.

Chapter 1: Representation of syntax

1.0 Thesis introduction and outline

The overall aim of the thesis is to conduct studies which test between generativist and constructivist accounts of syntactic linguistic representations in adults (and, indirectly, of their acquisition by children, although only adult studies are included in the thesis). All three studies investigate the passive construction (e.g., *The ball was kicked by the man*), which has long been seen as a suitable test-case for the competing approaches: deterministic rules versus probabilistic meaning-based constructions. Before presenting the studies (Chapters 3-5) – two conducted in English, one in Balinese – this thesis will (Chapter 1) outline (a) the general properties of these approaches (including some specific example theories of each type) (b) their accounts of the representation of word-order constructions (using the English active transitive SUBJECT VERB OBJECT construction as the primary example) and (c) evidence for these accounts (including from studies with children). Next (Chapter 2), the thesis presents their accounts of the passive construction along with evidence for and against each approach. Following the empirical chapters (3-5) the thesis concludes (Chapter 6) with a general discussion of implications and suggestions for future work.

2.0: Generativist vs constructivist approaches

As noted above, in this chapter, the general properties of generativist and constructivist approaches are first described briefly. We then explore evidence for and against the two general approaches, and some specific accounts under each approach, focusing on basic active declarative word order as a test case (e.g., SUBJECT VERB OBJECT) in English. We turn to the passive in later chapters.

This section describes the general properties of generativist and constructivist approaches as they relate to word-order constructions. The general question that these accounts try to explain is how speakers produce (and understand) sentences – a question which has always been at the centre of language studies. The ability to generate strings of words that form meaningful utterances has been explained by two different accounts: *generativist* (*rule-based, formalist, Chomksyan, Universal*

Grammar) and *constructivist* (*semantics-based, functionalist, empiricist, usage-based).* While generativist accounts propose that the speaker's innate knowledge governs and constrains formal syntactic rules in their language (e.g., Chomsky, 1981; Newmeyer. 2003; Guasti, 2004), constructivist accounts emphasize the accumulative experience of input which forms structures in their language (Croft & Cruse, 2004; Langacker, 2008). For acquisition researchers, the issue of innate versus accumulative linguistic knowledge is what separates generativist and constructivist accounts. When studying the adult endpoint, however – as in this thesis – what separates the two accounts is the opposition between formal semantics-free rules (that apply to any member of the relevant syntactic category) and semantics-based constructions (both of these are defined in detail below). Both questions – i.e., acquisition and adult representation – have inspired lengthy debate over the years in language studies, with each approach producing numerous pieces of evidence in support of its claims. Generativist accounts have long focused on syntactic and morphological operations, while constructivist accounts have highlighted the functional and socio-pragmatic nature of language.

With regard to word-order constructions – for which each account has its own claims and evidence – the difference can be seen for basic active declarative sentences consisting of a SUBJECT (e.g., *the man*), VERB (e.g., *kicked*), and OBJECT (e.g., *the ball*). At least for "word-order" languages like English, word-order marks the SUBJECT Noun Phrase (NP) and the OBJECT Noun Phrase (NP): For SUBJECT VERB OBJECT languages like English, in basic active declarative sentences (not questions, passives, etc.), the NP that appears before the verb is the SUBJECT and the NP that appears after the verb is the OBJECT. Under generativist accounts, there are several parameters that specify 'rules' that result in this order (see Gibson & Wexler, 1994), while constructivist accounts view the SUBJECT VERB OBJECT construction as having developed from slot-and-frame patterns over time (see Tomasello, 2003). Although a large portion of evidence for and against each accounts comes from first-language-acquisition studies with children, it is important to note – in particular with regard to the present studies – that the two accounts also make different predictions regarding adults.

One crucial distinction between the two accounts relates to the role of semantics. Chomsky (1957) noted that the grammatical acceptability of a sentence

such as *Colorless green ideas sleep furiously* demonstrates that syntactic rules cannot be reduced to rules of semantics. We can tell that this sentence is grammatically acceptable, even though it has no – or at least an unclear – meaning. Indeed, a semantic violation of selection (theta) restrictions occurs in the process: Though, in this example, the word *green* correctly selects a noun (*ideas*), it must modify some physical entity capable of exhibiting colour; but *ideas* fails to satisfy this restriction. Langacker (2008) however argues that the sentence can be recognized as grammatical by analogy to semantically meaningful sentences like *Harmless young dogs bark furiously*. The following chapters, including the new experimental studies, will provide evidence on the formalist/semantics-free versus constructivist/semantics-based debate illustrated by this example.

3.0 Rule-based/generativist accounts

3.1 General principles of generativist accounts

This section describes general principles of generativist, rule-based accounts. In terms of acquisition, the generativist-nativist theoretical proposal is one of innate linguistic knowledge and its presence from birth, even encoded in the genome. In terms of adult representation, generativist accounts propose that knowledge of grammar/syntax (and also inflectional morphology and phonology) consists of a set of formal 'rules' that operates abstract linguistic categories (e.g., VERB, NOUN) and phrases (e.g., NOUN PHRASE, VERB PHRASE). For example, the word *Dogs* (NOUN) and *barked* (VERB) can form a sentence *Dogs barked*; precisely (in English) in that order, not **Barked dogs*, reflecting the operation of syntactic rules and parameters. Although our primary focus is syntax, note that the VERB *barked* itself is constructed according to rules of morphological inflection, where its bare VERB form *bark* is combined with *-ed* to signal past tense. It is important to notice that not all generativist approaches are necessarily nativist, in the sense that not all knowledge of grammar assumed to be innate knowledge. In practice, though, most, if not all, generativist approaches adopt a nativist view too (at least in the language acquisition literature). A core nativist assumption is that of Universal Grammar (UG), a general grammar that applies to all world's language, and which is innately specified. Vice

versa, not all nativist approaches are generativist, since not all innate linguistic knowledge concerns grammar. For example, a set of studies in the word-learning literature have tested the *whole-object assumption* (e.g., Hollich et al, 2000); innate knowledge of speakers' tendency to refer to whole objects with their new words (rather than the properties or parts of it). This kind of approach is nativist, but not generativist, since the innate knowledge concerns with word meaning – not grammar.

One key assumption of generativist approaches (e.g., Chomsky, 1959) is that it is impossible for children to learn language only by imitative means– the language produced would consist of nothing more than a repertoire of rote-learned phrases. The fact that both adults and their children produce sentences that they cannot possibly have heard before has been taken, by generativist approaches, as evidence that a speaker's knowledge of a particular language consists of rules that allows her not only to produce novel utterances, but also to determine whether or not a particular novel sequence of words constitutes a possible sentence in that language.

3.2 Generativist accounts of basic word order

This section gives a brief description of generativist accounts of mature speakers' grammatical representations in relation to word-order constructions, focussing for simplicity on basic active declarative sentences (*John kicked Sue*). Chomsky (1959) argued that speakers must possess a system or set of rules that is generative and that applies to categories and phrases. If these formulas applied instead to individual words, a speaker would be confused with regard to word position whenever a new word was learned, and would have stored an impossibly large number of rules (i.e., a set of rule for each new word memorized). Instead, then, the proposed rule is formulated in terms of categories (e.g., NOUN) and phrases (e.g., NOUN PHRASE) that are abstract, not to the individual items (i.e., words such as *man*). Consider, for example, the simplest possible syntactic rule that combines two items:

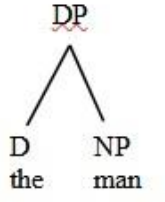

Figure 1. Syntactic rule of Determiner Phrase using tree diagram

While the example above shows only two syntactic categories, DETERMINER and NOUN PHRASE, combining to form a DETERMINER PHRASE, there are several other categories such as VERB, ADJECTIVE, and PREPOSITION that stored in the grammar. As can as be seen in the example, a phrase, such as DETERMINER PHRASE (DP) and NOUN PHRASE (NP), always has as its head a member of that category, i.e., NOUN for the NP, DETERMINER for the DP. Thus, *the* (D) and *man* (NP) in this example combine to form a single constituent (DP). For our purposes, the important point to stress is that the rule is formed in terms of phrases and categories, rather than individual words. That is, provided certain criteria are met, the rule can in principle apply to ANY determiner and ANY NOUN PHRASE. This is quite different to constructivist accounts which, as we will see later, assume an exemplar approach under which (at least at first and/or for frequent combinations) individual determiner+noun pairs (e.g., *the+man*) are stored and give rise to an abstract DP construction. To give a slightly more complicated example that shows the same principle, a simple transitive sentence *John kicked Sue*, would receive (assuming a simplified version of Chomsky's, 1995, minimalist approach) the syntactic analysis as follows

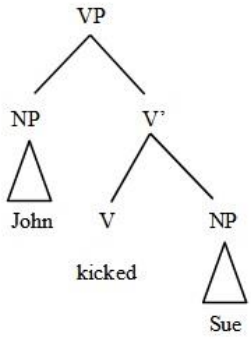

Figure 2. Syntactic rule of Verb Phrase using tree diagram

The use of V' (V bar) in this instance is to capture the fact that the combination *kicked Sue* – where the head is the VERB *kicked* – needs *Sue* (NP), an obligatory complement, to make the sentence grammatical. In contrast, an optional PREPOSITION PHRASE (PP) such as *on Tuesday*, would act as an adjunct. Again, the important point to note for our purposes is that these rules (i.e., VP=NP+V'; V' = V+NP) apply not to individual words but to abstract categories and phrases. This is

not to say that all rules apply to ALL category members. For example, as we will explore in more detail below, *kick* requires an obligatory complement, whereas an intransitive verb like *dance* or *laugh* prohibits one. However, these restrictions are stored in the verbs' lexical entries; they are not – as they are under constructivist accounts – generalized from the input on the basis of factors such as semantics.

These are very simple examples, and it is important to note that sentence construction can go much further than this via clause combination and through the use of functional categories such as pronoun (e.g., *he*), quantifier (e.g., *some*), negation (e.g., *not*), inflection (e.g., *-ing*), or complementizer (e.g., *that, which*). This brief explanation as to how a simple transitive sentence is put together is given simply as an illustration of the types of grammatical representations proposed by generativist approaches: the framework of X-bar theory; a generalized theory of phrase structure common to all individual language grammars within Universal Grammar (UG), originating with the Principles and Parameters approach (Chomsky & Lasnik, 1993).

3.2.1 Specific generativist accounts

Within this overall generativist framework, many individual accounts of adults' grammatical representations have been proposed. As representative examples we discuss phrase structure grammar (PSG), transformational grammar (TG) – in particular government and binding (GB) theory – as well as minimalism, lexical functional grammar (LFG), head-driven phrase structure grammar (HPSG), and dependency grammar (DG). The presentation of these theories given here is based on Müller's (2020) summary textbook on *Grammatical Theory*.

The oldest syntactic theory, DG (e.g., Tesnière, 1959; Anderson, 1971; Hudson, 1984, Helbig & Buscha, 2003; Ágel & Fischer, 2009), uses valence (a term in chemistry) to explain syntactic analysis as a form of dependency. For example, the valance of a transitive verb such as *kick* is a nominative NP subject (e.g., *John*) and an accusative NP object (e.g., *Sue*). In a sense, the use of the verb *kicked* alone leaves a question, who did it? as does only *John kicked*; John kicked what/who? Only when these questions have been answered have the verb's valency requirements been met. Note that valence does not specify word order; for this an additional linearization component is required. It is important here to emphasize that valence as a property of

the verb stored with its lexical entry, is deterministic, not probabilistic; a question of whether specific arguments (Subject or Object) are present or not. Thus, valence accounts would not seem to naturally explain the intermediate acceptability of phrases, such as *The magician vanished the card* since, *vanish* either selects an object as well as a subject (valence = 2) or (as it would be usually analysed) it does not (valence = 1).

For our purposes, the most important point to note about dependency grammar (along with LFG and HPSG, which are quite similar in nature) is that valence (or valency) is stored in the lexical entry for the verb (or other item) in the lexicon (a kind of "mental dictionary" of all words in the speaker's vocabulary). For example, the *valency lexical entry* (or *valency frame*) for *kick*, specifies a nominative NP SUBJECT (e.g., *John*) and an accusative NP OBJECT (e.g., *Sue*). Crucially, when determining which arguments are required for a particular verb, semantics plays no direct role: the required arguments are simply those specified in the lexical entry. Of course, semantics plays an indirect role in that semantically similar verbs *tend* to have similar valency lexical entries. But this information is not stored in the grammar; and it is only a tendency. As Herbst (2014) notes, "there is no guarantee that a particular lexical item with certain semantic characteristics will be able to occur in a particular valency pattern simply because other lexical items with the same characteristics do". Indeed, even different senses of the same verb are stored separately in the lexicon with different valency frames (e.g., transitive *roll* specifies a SUBJECT and an OBJECT; intransitive *roll* an OBJECT only). Another important to note is that valency is deterministic not probabilistic. The lexical entry for a given verb, with a given sense, specifies the required arguments in a deterministic, not gradient, fashion: Either a verb's valency frame includes an OBJECT (e.g., *kick*) or it does not (e.g., *dance*).

PSG (e.g., Chomsky, 1957; see also Generalized Phrase Structure Grammar; Gazdar, Klein, Pullum & Sag, 1985) emphasizes the rules specifying which symbols are assigned to which kinds of words and how these are combined to create more complex units (Muller, 2020: 53). Some of these rules can be seen in subject-verb agreement (i.e., singular/plural) and determiner-noun agreement (i.e., inflection class). The previous example of *the man* (Det+NP) illustrates the rule that a Determiner Phrase (DP) can consist of a determiner and a noun phrase; likewise, examples such as *the girl* or *an apple*. In a more complex sentence-level example, *John kicked Sue*

can be seen as resulting from a set of rules of the form S → NP_3_sg V' (V NP_3_sg), where 3_sg refers to third person singular (Muller, 2020: 57) followed by verb phrase that is a combination of a verb and a third person singular noun. Other examples of the same form can be created by the use of the same rules (e.g., *Sue punched John* or *She kissed John*). Again, the important point for our purposes is that semantics plays only an indirect role: the lexical entry for a verb projects its subcategorization frame(s) in a deterministic way.

The following development of TG – which subsequently developed into GB and minimalism theories – was introduced by Chomsky (1957) in an effort to capture the relationship between active and passive sentences, or between declaratives and questions. It is characterized by movement or "transformations". For example, the declarative form *He can eat X* is transformed into a question by *wh*-movement (*He can eat what → What he can eat?*) and then subject-auxiliary inversion (e.g., *What can he eat?*). For passives, Chomsky (1957: 43) proposes the following transformation (e.g., *John kicked Mary → Mary was kicked by John*) (example from Müller, 2020: 85).

NP V NP →3 [AUX be] 2en [PP [P by] 1]
1 2 3

GB theory divides PSG into two parts: deep and surface structure: PSG and lexical rules are included in the deep structure (D-structure), while phonetic form and logical form (i.e., quantification) are in the surface structure (S-structure). Since phrase structure rules operate on D-structure, items in S-structure (although derived from D-structure) should not necessarily be seen in the same position they have in D-structure (Muller, 2020: 88). For example, the VP *John kicked Sue* can be transformed to other constructions; i.e., *Does John kick Sue?* or even *Sue was kicked by John* as long as (using one of the principles, Theta-Criterion), *John* is seen as agent (acting individual) and the cause of an action (stimulus), while *Sue* is seen as patient (affected person or thing). Again, for our purposes, the important point is how semantics affects (or does not affect) verbs' possible argument structure frames. As for the previous theories discussed "The lexicon contains a lexical entry for every word which comprises information about…selectional properties…There are several terms used to describe the set of selectional requirements such as *argument structure, valence frames,*

subcategorization frame, thematic grid and *theta-grid* (Müller, 2020: 88-90). Again, it is not the case that semantics plays *no* role. On the contrary, a verb's lexical entry specifies the required theta-role for every argument, as in the following example from Müller (2020: 92):

• Class 1: agent (acting individual), the cause of an action or feeling (stimulus), holder of a certain property
• Class 2: experiencer (perceiving individual), the person profiting from something (beneficiary) (or the opposite: the person affected by some kind of damage), possessor (owner or soon-to-be owner of something, or the opposite: someone who has lost or is lacking something)
• Class 3: patient (affected person or thing), theme

Again, though, these roles are projected in a deterministic, rather than probabilistic way, and are fully determined by a verb's lexical entry. As per Herbst's (2014) quotation regarding valency approaches, there is no need for semantically similar verbs to necessarily have similar "c-selection" (syntactic arguments) or "s-selection" (semantic-role) properties.

Minimalism (e.g., Chomsky, 1993) then took a slightly different approach compared to GB in using two rules of external (combination) and internal (movement), "merge" in syntactic analysis (Chomsky, 1993). In Minimalism, two forms of merges (internal and external) were laid out to replace the concept of D-structure, which derived from articulatory-perceptual (or the Phonological Form in GB – sound) or conceptual-intentional (or the Logical Form in GB – meaning) rules (Muller, 2020: 128). Development of previous DP *the man* into *the man who we know;* for example, can be explained by how the verb *know* is externally merged with its object *who*, *know who* will then be merged with *we* and the *who* is moved to the left by internal merge, resulting in *who we know* – creating a clause that externally merged with *man*. Minimalism dispenses with movement and theta-roles; instead – under the split-VP approach – there is no direct relationship between "equivalent" active and passive sentences; neither do verbs "project" a particular argument structure. Instead, all sentences are created via the general principles of "move" and "merge".

Another broadly-generativist approach to syntax is in LFG (e.g., Bresnan & Kaplan, 1982) that posits constituent (c-structure) and functional (f-structure) structures on its representation. While c-structure can be defined through PSG, f-structure contains information about the predicates involved and grammatical functions which occur in a constituent (Muller, 2020: 223). It is important to note that LFG differentiates grammatical functions into the governable and non-governable ones (i.e., topic and focus in information structure). Therefore, in the example of *John kicked Sue*, governable grammatical functions are subject for *John*, predicate for *kick*, and object for *Sue* – while the non-governable grammatical functions are topic (given information) of *John* and focus (new information) of *Sue*. The use of these 'labels' will enable a clear distinction and explanation of the relationship between similar construction; e.g., the active *John kicked Sue,* and the passive *Sue kicked by John*. Following LFG, HPSG (Pollard & Sag, 1987; 1994) was then introduced to abolish these different constituents (e.g., PF and LF in GB) – then combining phonology, syntax, and semantics into one analysis through focusing on feature specifier (SPR) and complements (COMPS) of head-daughter relationship in a constituent structure (Muller, 2020: 270). Rather than separating the analysis of phonology and grammatical functions, early version of HPSG introduced the feature of subcategorization (Pollard & Sag, 1987). In the sentence *John kicked Sue,* HPSG can determine the verb *kicked* as a head and *John* or *Sue* as NP[nom], which enable other possible similar constructions – replacing only the verb as its head; e.g. *John kissed Sue* or *John called Sue*. This is only possible due to the feature structures of verb *kicked* that can be represented in [phonology *kikt*, syntax-semantic (local, category (head-verb, specifier-noun), content (*kick*)]. The heavy use of semantics in LFG/HPSG means that, unlike the other generativist theories discussed here, it overlaps to a significant degree with constructivist accounts (see section 4.2 and 5.0). Nevertheless (as the name ***lexical functional grammar*** makes clear) verb's arguments are still determined in the lexicon, and hence deterministically, not probabilistically.

3.3 Generativist accounts of acquisition

The focus of this thesis is the nature of grammatical representations in adults, rather than their acquisition by children. However, theories and studies of children's

acquisition can also contribute towards our understanding of adult representations, since the "end phase" of an acquisition process can be understood in terms of the processes that led to the formation of those representations. With regard, again, to the phenomenon of basic word order, we briefly discuss two accounts that serve as good examples of generativist accounts of acquisition more broadly; they are the semantic bootstrapping and parameter-setting account.

Semantic bootstrapping was proposed by Pinker (1984, 1987, 1989a), to explain the acquisition of basic word order, given the circularity of the system. For example, a child learning English must learn that the SUBJECT NOUN comes first, then the VERB, then the OBJECT NOUN. But how can the child recognize these categories in the input when NOUN, for example, is defined circularly: e.g., NOUN can appear with determiner (e.g., *the X*) or marked for number (e.g., *Two Xs*). Under this account, children's innate knowledge consists not only of an inventory of syntactic categories, but also an inventory of semantic categories and a set of linking rules linking the two on the level of lexical categories (e.g., PERSON/THING → NOUN, ACTION→VERB) and grammatical relations (e.g., AGENT → SUBJECT). These relevant categories can then be used to parse incoming sentences, provided the child knows the meaning of some of the words used, and can tell whether they are agent or patient. For example, *The man* (AGENT) *kicked* (ACTION) *the ball* (PATIENT) is evidence that English follows AGENT ACTION PATIENT word order and – via the innate linking rules – SUBJECT VERB OBJECT word order. A potential problem that appears is that some words break these linking rules (e.g., the noun *[a] kiss* is more an ACTION than a PERSON/THING, yet it is a NOUN, not a VERB). Pinker (1987) then proposed the modification of adding probability to the linking rules, such that distributional information would compete with syntactic rules "read-off" the innate linking rules. It is interesting to note the extensive emphasis on semantics, which is unusual for a generativist-nativist account, and even shares some similarities with a constructivist account. However, it is important to note that semantics are only used at the early stages – the linking rules then give the usual categorical rules that can apply to any category members.

Another generativist approach to the acquisition of basic word order is parameter-setting (e.g., see Gibson & Wexler, 1994). The assumption is that learners set

(1) a complement-head (or head-direction) parameter reflecting the head and complement position (e.g., in English, a simple VP always has its head of V before the complement of NP; e.g., *kick the ball*, not *the ball kick*)

(2), a specifier-head parameter reflecting the order of the specifier (e.g., NP) and the head (e.g., V); e.g., *The man kicked…* not *Kicked the man…* in English).

(3) V2 parameter reflecting whether or not a finite verb (i.e., a verb marked for tense) must always be the second constituent of all declarative main clause (e.g., in a V2 language like German one must say *[The man] [**kicked]** [the ball]*, but *[Yesterday] **[kicked]** [the man] [the ball]*)

(4) A null-subject parameter that determines whether subjects are obligatory (e.g., English) or may be omitted (e.g., Spanish)

The idea is that children set each of these parameters by using the language that they hear, and therefore arrive at the word-order rules for their language (e.g., giving SVO word order for English). Through the use of these parameters in a triggering learning algorithm (TLA), at least provided ambiguous sentences can be avoided, these parameters allow the learner to converge onto the correct grammar.

This raises the issue of how learners know which word is the specifier, the head, the subject etc. As a solution, Mazuka (1996) proposed that children have innate knowledge of a correlation between branching-direction and word order. Branching direction is the direction of additional subordinate clauses to be added into a sentence (e.g., English, is right-branching, and this is correlated with the head-then-complement order of the head-direction parameter). Learners could identify branching direction via pitch change, which is greater for subordinate/main clause boundaries rather than main/subordinate clause boundaries. Christophe et al (2004) proposed that learners are sensitive to a correlation between phonological prominence (raised pitch, syllable change, and stress) and branching direction. Their study found evidence that even infants are sensitive to phonological prominence (though does not address the question of whether they can use it, via parameter setting, to arrive at the correct grammar).

Both semantic bootstrapping and parameter-setting account may seem to be plausible accounts of word order acquisition. However, the relevant innate knowledge (linking rules; correlations between phonological prominence and branching direction) would need to be uniform (or at least similar) across languages for them to be applicable, and it is far from clear that this is the case (see Ambridge, Pine & Rowland, 2015, for a review).

3.4. Generativist accounts: Summary

The goal of this brief introduction has been to give the reader a flavour of generativist approaches to syntax (and its acquisition): Broadly speaking, generativist accounts see adult representations in terms of rules that apply to categories and phrases, not to individual words. Importantly, these rules can operate without reference to the meanings of these words, and many of them have some innate basis (i.e., exist in some form before learners know any word meanings at all). This contrasts with constructivist accounts that place semantics or meaning (and meaning-based gradual generalization from the input) at the centre.

4.0 Constructivist accounts

4.1 General principles of constructivist accounts

This section gives a brief overview of constructivist (or *functionalist/usage-based/input-based/socio-pragmatic*) accounts of adult syntactic representations (contrasting them with generativist accounts). The constructivist approach (e.g., Langacker, 1987; Lakoff, 1987; Pine & Lieven, 1993; Goldberg, 1995, 2007; Kay & Fillmore, 1999; Croft, 2001; Tomasello, 2000) is both non-nativist and non-generativist, and rejects the proposed innate knowledge of grammar and the operation of formal rules on categories. While the *ability* to learn language is innate (and specific to humans), the acquisition of grammatical categories and representations is through generalization across the speech that is heard (for this reason the approach is called *input-based*, with words and constructions acquired – amongst other things – according to their input frequency; See Ambridge, Kidd, Rowland & Theakston, 2015

for a review). Again, as previously mentioned with regard to generativist accounts, acquisition research is useful for making inferences about the adult endstate, even though it is not the focus the present research.

To see the difference between constructivist accounts and rule-based generativist accounts, consider the example of the VERB *barked*. The constructivist account does not view this form as the output of a 'rule' that add *-ed* to *bark*, but rather as analogy of similar sounding pairs of *bark → barked* that have been encountered in the input (e.g., *park→parked*, and more distantly, *walk→walked, talk→talked* etc.). The important difference for our purposes is that the generativist account proposes a categorical rule (add *-ed*) that can apply to any verb (apart from learned exceptions) regardless of its sound and its meaning (e.g., Pinker, 1999; Pinker & Ullman, 2002). The constructivist account proposes a more fuzzy, probabilistic generalization, with past tense marking analogized between verbs with similar sounds (e.g., Rumelhart & McClelland, 1986) and to some extent meanings (e.g., Ramscar, 2002); both of which are irrelevant (for the regular *-ed* "rule") under generativist accounts. That is, any constructivist proposal can be viewed as an emergentist proposal. Constructivist accounts are also known as *functional* and *socio-pragmatic*, where functional refers to the use of particular forms in communicative functions, and socio-pragmatic refers to the interference of attention and communicative intentions (e.g., a speaker who produces a word whilst looking at an object and attending to that object presumably intends to label that object). Thus while, for example, distributional analysis is proposed under non-constructivist accounts too (e.g., as we have seen, Pinker, 1989), constructivist approaches (e.g., Tomasello, 2003) propose *functionally based* distributional analysis; grouping of words not only on the basis of appearing in similar sentence positions, but also of their meanings and communicative functions. Since constructivist approaches focus on the way that speakers use language to perform certain functions (e.g., describing an event, requesting an event), this approach is also known as the *functionalist* or *usage-based* approach.

The principles of grammar and sentence construction under constructivist accounts are relatively different to generativist "rules". Instead, the grammar is viewed as a structured and accumulative inventory of constructions. In this definition, a construction is viewed as form-meaning pair such that some aspect of the form or of the function are not strictly predictable from the component parts, or other previously

established construction (Goldberg, 1995). For example, the entire sentence *The man kicked the ball* would not (necessarily) be stored, because the form (i.e., its word order) and its function (i.e., its meaning) ARE strictly predictable from the component parts (*kick, ball, the* etc.,) and from a previously-established construction; here the SUBJECT VERB OBJECT transitive construction. In contrast, the idiomatic phrase *kick the bucket,* WOULD need to be stored as a construction in its own right, as the meaning ("die") is NOT predictable from its component parts, or from the meaning of the construction. Constructivist approaches are further characterized by three "essential principles of construction grammar" (Croft & Cruse, 2004) (a) independent existence of constructions (i.e., constructions are stored in speakers' grammars, as opposed to just being the output of generative rules), (b) uniform representation of structure (constructions can be at any level, from single words to whole sentences), and (c) taxonomic organization of construction in grammar (e.g., *kick the bucket*), although stored as a separate construction, is linked to the SUBJECT VERB OBJECT construction and inherits its word order.

4.2 Constructivist accounts of basic word order

As for generativist approaches earlier, a useful way to understand the constructivist account is to explore its explanation of how words are put together to form sentences, focusing again on basic active declarative transitive sentences. Under the constructivist/construction grammar approach – as mentioned above – language is an inventory of construction (utterance templates) of various sizes and levels of abstraction, each of which serves some communicative and socio-pragmatic function. For example, the form (i.e., pattern) that is associated with a function (i.e., meaning), can be seen in an example sentence *John kicked Bill*. The form (pattern) is NOUN1 VERB NOUN2, and the meaning is something like 'A acts upon B, causing B to be affected in some way' (e.g., Goldberg, 2007). Although acquisition is not our particular focus here, one important aspect of construction grammar is its learnability (in contrary to the innateness of generativist grammar). Early item-based constructions like *I'm ACTIONing it* (or also called patterns or schemas) can in principle, be readily learned from the input and paired with a meaning or communicative function that the speaker understands (e.g., ACTION is not an adult-like syntactic category of verb, but

rather a simpler functional category of actions that the speaker can perform). Under this notion, the particular constructions that speakers store will depend on the sentences they hear. If a speaker hears a number of highly similar sentences where just one item is different each time, she is likely to form an item-based construction around the invariant material (e.g., *I'm ACTIONing it*). Conversely, if a speaker hears exactly the same utterance repeatedly with no variation (e.g., *What's+that?;* e.g., Rowland & Pine, 2000) she is likely to acquire the utterance as a 'frozen phrase' with no variable slots.

Based on Croft and Cruse (2004), the first essential principle of construction grammar here is the independent existence of constructions, where rather than positing many different kind of senses to various lexical items (e.g., a verb that clearly denotes similar same actions in senses – such as *kick* in *kick the ball* and *kick the habit*), part of the overall utterance meaning is contributed by the meaning of the construction itself (e.g., A acts on B). The second principle, of uniform representation of structure, entails that each semantic structure (every form that is associated with a particular meaning), is considered to be a construction, regardless of its length. By including individual words as a construction, as well as sentence/utterance-level constructions like SVO, inflection (how *-ed* can be "added" to the VERB *kick*) can be explained through the same framework. The third principle of taxonomic organization of construction in grammar is akin to a family tree, where 'daughters' inherit properties of their 'parent'; i.e., the construction of [SUBJ] *kick the ball* and [SUBJ] *kick the habit* are both instantiations of [SUBJ] *kick* [OBJ], which in turn is an instantiation of the broader construction [SUBJECT] [VERB] [OBJECT]. When a speaker stores the word *kick*, there is no need for her to store the fact that the SUBJECT comes before the VERB and the OBJECT after. All she needs to store is the fact that *kick* is the daughter of the SUBJECT VERB OBJECT construction.

As with generativist accounts, as discussed above, the overall constructivist/construction grammar framework incorporates various different individual theories (e.g., see Müller, 2020), including sign-based construction grammar (SBCG), embodied construction grammar (ECG), and fluid construction grammar (FCG). (Additionally, many concepts from construction grammar can be related to equivalent concepts in HPSG – particularly the use of mother-daughter relationships of inheritance).

SBCG was originally derived from HPSG – differing through the use of geometry of typed feature structures (atoms and functions value) in the description of semantic content (Sag, 2010). Specifically, the difference with HSPG can be seen through the addition of 'mother' in its geometry and omission of valence structure or removal of 'daughter' (Muller, 2020: 329). The main principle of this concept (and how it relates to the notion of construction grammar) is how it viewed a sign as constructionally licensed if it is the mother of some well-formed construction (Sag, 2012: 105). For example, a verb *kick* can be used in a construction as a head that is accompanied by a specifier (SPR) of NP[nom] through looking at the mother (in this case, phrase) *the man kick the ball* that has the same values (an instantiation from the mothers' value). While generally similar, ECG took this view further by using dynamic inferential semantics (internal activation of embodied schemas) – generalization of recurrent perceptual and motor experiences, along with mental simulation of the representation in context (Bergen & Chang, 2005). What this means is that aside from the form (phonological) and meaning (conceptual), communicative context is also considered in the form of a schematic structure (this structure is referred as an 'embodied schema'). For example, *the man kicked the ball* – invokes the embodied schemas of "force-application" (i.e., from *the man*), "cause-effect" (i.e., an action of *kick*), and "receive" (i.e., to *the ball*), which link to the AGENT, THEME and PATIENT elements of the construction. FCG, on the other hand, separates syntactic and semantic features prior to merging them through generation and parsing (van Trijp, 2013: 99). Considering, for example, the utterance *he sent her the letter*, the verb (head) *sent* can have semantic roles of (accompanied by) AGENT, PATIENT, RECIPIENT, and GOAL along with syntactic roles of SUBJECT, DIRECT OBJECT, INDIRECT OBJECT, and OBLIQUE. Consequently, there there are three possible constructions – *he sent her the letter*, *he sent the letter*, and *the letter was sent to her* – through relating these syntactic and semantic features/poles. Note that based on this phrasal approach to argument structure in FCG, it is necessary to have a passive variant of every active construction (van Trijp, 2011: 122).

Another characteristic of constructivist/construction-based accounts is that they are exemplar-based accounts (e.g., Goldberg, 1995; 2007; Dabrowska, 2002). All constructivist accounts assume that constructions emerge from generalization across stored exemplars, but most accounts further assume (see Abbot-Smith & Tomasello,

2005; Ambridge, 2020) that these exemplars are not then discarded, but continue to be stored.

For our purposes, the most important characteristic of constructivist/construction-based accounts is that ***constructions have meanings in and of themselves***. We have already discussed the example of the transitive causative construction, and its meaning of 'A acts upon B, causing B to be affected in some way'. The (proposed) meaning of another construction – the passive – is used in the studies in this thesis as a test case for constructivist (versus generativist) accounts of the adult grammar.

4.3 Constructivist accounts of acquisition of basic word order

This section discusses several studies that characterize the constructivist approach to the acquisition of basic word order. Although they are studies of acquisition, rather than of the adult endstate per se, they serve as a useful illustration of the representations that adult speakers ultimately arrive at under this approach. Again, our focus is on the SUBJECT VERB OBJECT active transitive declarative construction. Tomasello (2003) proposed that children use relational overlap (between many pairs of schemas) and analogize across them via a process of structural alignment. In this way, children move from frozen-phrases (e.g., *I'm eating it; Mummy kissed Daddy*) to slot-and-frame-patterns (e.g., *I'm [ACTION]ing it* and *[KISSER] kissed [KISSEE]*) to fully abstract constructions: [AGENT] [ACTION] [PATIENT] and, eventually, SUBJECT VERB OBJECT.

With respect to the transitive construction, a number of studies (see Ambridge & Lieven, 2011: 221 for a review) have been conducted to investigate elicited-production with novel verbs. Although these studies were conducted with children, as mentioned before, these findings can be used to make inferences regarding adults' constructional end state. Children were trained in the use of novel verb (e.g., *This is called "tamming"*) and then tested to see if they were able to use this verb in an unattested transitive construction (e.g., *Ernie is tamming the ball*). One particularly interesting finding is that children's production of novel SVO utterances mostly (e.g., 90% in Dodson & Tomasello, 1998) used pronouns (e.g., *He's tamming it*), suggesting that children were relying heavily on the use of slot-and-frame schemas such as *He's*

[X]ing it. In a similar "weird-word-order" study by Akhtar (1999), children used pronouns almost exclusively when correcting "weird-word-orders" presented for novel verbs to SVO; i.e., from *Elmo the car gropping* to *He's gropping it*. Since children did not use pronouns in the SOV or VSO constructions, it suggests that they rely heavily on slot-and-frame schemas such as *He's [X]ing it* in the SVO transitive. This finding was also observed in comprehension studies conducted by Childers and Tomasello (2001, Study 2). Several studies using preferential-looking and pointing (Gernter, Fisher & Eisengart, 2006; Noble, Rowland & Pine, 2011; Fernandes, Marcus, Di Nubila & Vouloumanos, 2006) have investigated whether children look longer at, or point to, a video screen that shows a matching than mismatching action for the transitive construction (e.g., *The duck's glorping the bunny*), and have suggested earlier abstract knowledge of the transitive construction (age 2;0 or even just below). However, similar studies by Chan, Meints, Lieven, and Tomasello (2010) and by Dittmar, Abbot-Smith, Lieven, and Tomasello (2008) have found that children succeed only with pre-training on the task. Together these findings suggest the *gradual* emergence of an abstract [X] [Y] [Z] transitive construction, where the [X] slot is probabilistically associated with properties such as moving first, moving towards the other character, instigating contact with this character, and so on (Abbot-Smith & Tomasello, 2006).

With regard to construction meaning, perhaps the most direct study of the semantics of the transitive causative construction is a child pointing study (Ambridge, Noble, & Lieven, 2014). When presented with ungrammatical Noun Verb Noun (NVN) uses of intransitive-only verbs (e.g., **Bob laughed Wendy*) and given a forced-choice pointing task, adults tend to select a causal construction-meaning interpretation (e.g., *Bob* ***made*** *Wendy laugh*) rather than a non-causal sentence-repair interpretation (e.g., *Bob laughed* ***at*** *Wendy*). This pattern even holds regardless of verb frequency (high, low, or novel). That is, speakers are so affected by the "cause" meaning of the SVO transitive construction that they choose this meaning, even though it requires coercing the verb into an incompatible argument structure, rather than a meaning which allows a fully grammatical "repair". This is powerful evidence for construction meaning, and is difficult to explain under "valence" type accounts (see above), which would not posit a two-argument frame for *laugh*: Construction semantics is used to interpret ungrammatical sentences, even if it is through overriding knowledge

regarding the usual meanings and valence/argument-structure restrictions of particular verbs.

5.0 Generativist vs Constructivist accounts

In this chapter, we have explored the broad outlines of the generativist and constructivist approaches to adult grammatical representations, and – in more detail – some particular generativist and constructivist accounts. In relation to this thesis, our concern is primarily adult representations though, as we have seen, the representations of this adult endpoint can also usefully be studied via language acquisition studies with children.

An important principle of the generativist approach is that innate linguistic knowledge of categories and rules is necessary due to the highly complex, and infinitely generative/productive nature of language. The constructivist account argues that the solution to this problem lies with accumulating an inventory of constructions. Nevertheless, these accounts do not fully contradict or oppose each other. Generativist claims of innateness refer only to some (and relatively few) core aspects of innate knowledge (particularly, for example, Hauser, Chomsky and Fitch, 2002), who propose that only recursion is innate). Construction grammar/constructivist approaches derived from syntactic studies with their origins in a generative approach (LFG, HPSG), as noted – for example – by Pinker (2013: xv):

> the analyses in Learnability and Cognition (Pinker, 1989) are upward compatible with [both] current versions of Lexical Functional Grammar and the various versions of Construction Grammar, such as those developed by Ronald Langacker, Adele Goldberg and William Croft. Indeed, my notion of the "thematic core" of an argument structure, which delineates the "conflation class" of verbs compatible with that argument structure, is very close to the idea of a "construction meaning" invoked by theories of construction grammar.

Conversely, although the constructivist approach places emphasis on the link between form and meaning, it does not fully abandon the concept of formal structure

(particularly historically older forms of construction grammar that are close to LFG and HPSG).

Differences, however, do remain. In general, the debate between generativist and constructivist approaches to the adult grammar centres around the question of whether human syntactic knowledge is best captured by (a) symbolic categories and phrases, and rules operating on them – rules that can in principle operate without reference to semantics (other than indirectly, by means of a verb's lexical entry)– or (b) probabilistic constructions that have been built up gradually on the basis of input, and that have meanings in and of themselves. As Müller (2020: 587) notes

> …a rather crucial aspect when it comes to the comparison of…theories [is that of] valence and the question [of] whether sentence structure, or rather syntactic structure in general, is determined by lexical information or whether syntactic structures have an independent existence (and meaning) and lexical items are just inserted into them. Roughly speaking, frameworks like GB/Minimalism, LFG, CG, HPSG, and DG are lexical, while GPSG and Construction Grammar (Goldberg 1995; 2003a; Tomasello 2003; 2006b; Croft 2001) are phrasal approaches. This categorization reflects tendencies, but there are non-lexical approaches in Minimalism (Borer's exoskeletal approach, 2003) and LFG (Alsina 1996; Asudeh et al. 2008; 2013) and there are lexical approaches in Construction Grammar (Sign-Based Construction Grammar). The phrasal approach is wide-spread also in frameworks like Cognitive Grammar (Dąbrowska 2001; Langacker 2009: 169) and Simpler Syntax (Culicover & Jackendoff 2005; Jackendoff 2008)

Although, in practice, few researchers would place themselves as the extreme ends of this continuum (Newmeyer, 2018), a contrast can be drawn between **formalist/pure-syntax/lexicalist** approaches (e.g., Chomsky, 1993; Newmeyer, 2003; Culicover et al, 2005; Adger, 2017; Branigan & Pickering, 2017), and **functionalist/constructivist, semantics-based** approaches (see Goldberg, 1995; 2006; Langacker, 2008). The three studies presented in this thesis use the passive construction, in English and Balinese, as a test case for these two competing approaches. Lexical (generativist/formalist/pure-syntax) approaches assume that – provided its lexical entry contains this structure –

any verb can appear in a passive utterance and will be equally grammatically acceptable (since lexical entries are deterministic, not probabilistic). Phrasal (constructivist/functionalist/semantics-based approaches) assume that the passive has a meaning in and of itself, and verb's acceptability in this construction will be related – in a graded way – to the fit between its meaning and that of the construction.

Chapter 2: Theoretical approaches to the passive

1.0 Why passives.

The key characteristic of the passive as compared to simple basic sentences is its noncanonical linking between semantic (AGENT/PATIENT) and syntactic roles (SUBJECT/OBJECT) – opposite to that observed for basic canonical 'who did what to whom' sentences (i.e., the passive SUBJECT is a PATIENT, not an AGENT; the passive OBJECT – if present – is an AGENT).

The study of the passive has played a significant role in early language acquisition research, due to the fact that it involves both morphological inflection and construction of the noncanonical sentences. The passive has also proved a useful testing ground for generativist versus constructivist approaches: Generativist (Universal Grammar) accounts would seem to predict that, in principle at least, children should be able to produce and comprehend passive as early as they can be tested – while constructivist accounts would argue that the passive is learned gradually from the input (e.g., Ambridge & Lieven, 2011: 272). Although both views agree that children struggle with full passives until at least age 3 years, the explanations they offered are quite different: Generativist researchers have argued that the difficulty lies with task demands or methodological issues, while constructivist researchers argue that children start off with only fixed frames, and their knowledge of the passive becomes increasingly abstract as they develop.

Older studies started this debate by focusing on different findings for actional and nonactional verbs (e.g., Pinker et al, 1987), argued to support the generativist claim of maturation (e.g., Borer & Wexler, 1987). As more studies were conducted with an increasing focus on children's passive production (as opposed to comprehension), the difficulty of supplying *by*-phrases (e.g., [*X was VERBed] by Y*) in passive sentences also became apparent (Fox & Grodzinsky, 1998). More recent studies – particularly studies relevant to this thesis centred around full passives (as opposed to truncated passives with no *by*-phrase; i.e., the AGENT is not mentioned) – focused on GET and BE passives (e.g., Budwig, 1990). As we will see in more detail below, both comprehension and priming studies (e.g., Savage et al, 2003; Bencini & Valian, 2008;

Messenger et al, 2012; Ambridge et al, 2016) have provided evidence for and against a semantic affectedness constraint as proposed by Pinker et al (1987).

The following sections will outline details of both generativist/formal and constructivist/semantics-based accounts along with the corresponding studies in both children and adults that provide evidence for and against both accounts.

2.0 Generativist/formal accounts.

In this section, we focus on linguistic theories of adult representation of the passive; in particular on the theories set out in the previous chapter: dependency grammar (DG), phrase structure grammar (PSG), transformational grammar (TG), the government and binding (GB) approach, minimalism, lexical functional grammar (LFG), and head-driven phrase structure grammar (HPSG). The theoretical approaches to passive covered here are mostly in terms of lexical entries and/or valence frames that do not naturally accommodate semantic effect in the construction, since they do not contain gradient representations. In terms of semantic effects on the passive, Pinker, Lebeaux, and Frost (1987: 249; see also Pinker, 1989) propose that passivization is restricted to verbs that denote actions or events such that

[B] (mapped onto the surface subject [of a passive]) is in a state or circumstance characterized by [A] (mapped onto the by-object or an understood argument) having acted upon it.

To understand this idea of a graded semantic representation, consider the following examples

(1) John kicked Sue / Sue was kicked by John (AGENT-PATIENT verb)
(2) John frightened Sue / Sue was frightened by John (THEME-EXPERIENCER verb)
(3) John saw Sue / ?Sue was seen by John (EXPERIENCER-THEME verb)
(4) The book cost £5 / *Was cost by the book (“situational” verb).

The difference between the acceptability passives with these verbs can be explained by Pinker's (1987) semantic constraint (1987), where the actives sentences in (1) are (2) easily passivizable as compared to (4) and, to a lesser extent (3).

In DG, passive is treated as a lexical process, where it is assumed that there is a passive participle that has a different valence requirement from the corresponding active form (Müller, 2020: 375). In deriving a passive utterance such as *Sue was kicked by John* from the active *John kicked Sue*, an argument transfer renders the subject (*Sue*) an argument of the auxiliary (*was*) rather than of the main verb *(kick*). In terms of syntactic analysis, this transfer allows the separation of the verb (*kicked*) and its SUBJECT (*John*), rather than having the NP (*John*) as a part of the VP (NP+VP). As previously mentioned, this suggests that passivizability is represented in the lexical entry for the verb (or, more properly, for the passive participle).

The characterization of the passive in PSG presented here is based on its analysis in Generalized Phrase Structure Grammar (GPSG), which proposes a metarule linking the passive rule and the active rule (with a suppressed subject) – passives are said to be actives with a suppressed subject rule. The active and passive rules themselves are unrelated structures; "one is not derived from the other" (Müller, 2020: 194). The problem with this analysis is how valence is encoded in phrase structure rules (since the active and passive are not transformations of one another), particularly since the AGENT is not always present in the passive form (e.g., *Sue was kicked* – with no *by*-PP). This is a problem since the subject (*Sue*) is always necessary in the passive form (e.g., *kicked by John* requires *Sue was*), but it is not always possible to derive the phrase structure rules of S+VP from its head (the head of this both active and passive structure is VP –from the verb *kicked*). Using unrelated – but meta-linked – rules (as shown by the rule for the subject) for each structure, can lead to inadequate representation of semantic relations between actives and passives.

The relationship between passive and active in TG is characterized by the use transformational rules that map between trees built from the same class of symbols; i.e. the active (e.g., *John kicked Sue*) and the passive (i.e., *Sue was kicked by John*) are both constructed using the rule of S+NP+VP, but the daughters of each VP are different (i.e., the passive is more complex – it requires AUX (i.e. *was*) and the NP is the daughter of PP since the *by*- phrase is needed), as illustrated in Figure 3.

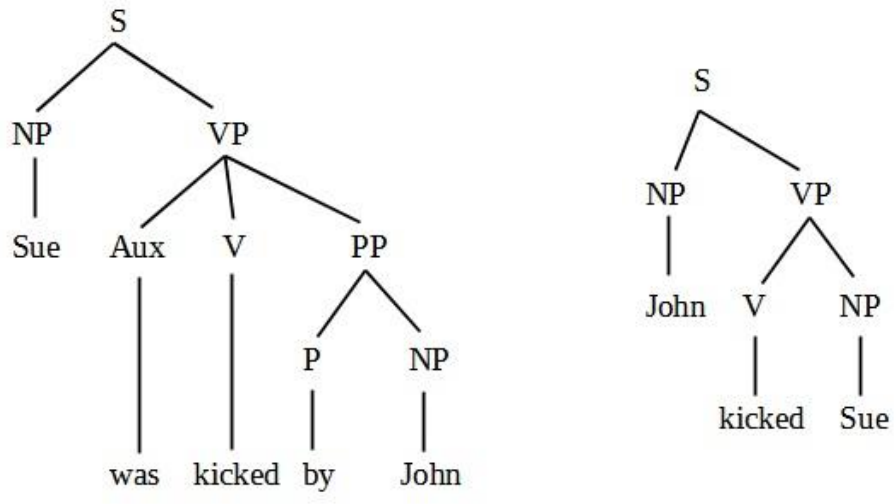

Figure 3. Active and Passive constructions under Transformational Grammar (TG)

While it is true that both sentences have the same classes (NP+VP), when tested with other sentence examples (e.g., *John saw Sue; The book cost £5*), it is clear that there is no restriction on potential daughters of the passive VP (Müller, 2020: 86). In a more extreme example, one of the highest complexities of the passive transformational grammar rule can be seen in Type-0 (e.g., *By whom had the call been put through to Chicago before John left*) as mentioned by Peters & Ritchie (1973). "the factorization to which the passive transformation is to be applied has the structure: anything, a noun phrase, an auxiliary, a verb, anything, a noun phrase, anything, the passive marker, anything" (Peters & Ritchie, 1973: 63). Through brief comparison, it seems that this type of complex passive construction does not conform to that shown in Figure 3. This Type-0 transformation does not fall into the disprefered/ungrammatical utterances as in (3) and (4), but it also demonstrates the difficulty of applying and balancing 'rules' as the construction grows semantically.

GB as a new theoretical approach that departed from TG, tried to solve this problem through means of 'restricted' transformation, which enables recovery of the original representation (active or passive), and hence access to the necessary semantic representation. However, by creating restriction/rules, certain generalizations have to be meet, and following the licensed of syntactic categories (i.e., verb, noun, adjective,

preposition, adverb), several feature combinations of these categories, and even with cross-classification afterwards, this generalization still runs into problems.

In Müller (2020: 94), the combination of four syntactic categories through binary features enable the generalization; using Verb and Noun role, the binary for Preposition would be [-N, -V], Noun would be [+N, -V], Verb would be [-N, +V], and Adjective would be [+N, +V]. For example, the use of the syntactic category Adjective would generally require both a Noun and Adjective in its sentence construction (e.g., *John kicks hard* – what is hard? The kick; who/what is doing it? John). In other words, for example, lexical categories that would require Verb (+V) are either adjectives or verbs. This restriction/rules through generalization and cross-classification of categories would later need new categories and several additional possible feature combinations to explain the functional categories; thus, GB does not use this binary (absence or existence) concept for the functional categories (i.e., Determiner would be simply categorized by article and demonstrative – it is not cross-classified with other functional categories; e.g., complementizer). Furthermore, the GB approach explained structural case problem with passive, where "passive morphology blocks the subject and absorbs the structural accusative. The object that would get accusative in the active receives only a semantic role in its base position in the passive, but it does not get absorbed case. Therefore, it has to move to a position where case can be assigned to it" (Chomsky, 1981a: 124). Under this analysis, the role of Subject and Object in passive is justified through how – in particular – the Object position in active 'must' move to its position in the passive to retain the structural case (relevant to the accusative verb) that originally apparent in the active. This claim of realization can be seen in the example of GPSG above (the necessity of AGENT and suppressed subject rule in passive), since GPSG is a product of GB.

The core difference between GB and Minimalism with regard to the passive is the role of accusative and unaccusative verbs in the transformation from active to passive. The emphasis of Minimalism can be seen in the following example from Adger (2003: 190): The verb *killed* can be categorized as passivizable since it is accusative; *John was killed by Sue*. The verb *arrived*, however, is an unaccusative verb, and this categorization means that it is impossible for this verb be passivized in full (i.e., with the use of *by*- phrase; **John was arrived by Sue* or **There was arrived by Sue*; c.f., active *Sue arrived there*). "Unaccusative verbs are similar to passivized

verbs in that they do have a subject that somehow also has object properties" – yet cannot be passivized (Müller, 2020: 141). Unaccusative verbs are also used in agent-less constructions (Müller, 2020: 628) – which implies that such verbs do not have a semantic agent (do not require an agent semantically). The emphasis on a binary split between these two types of verbs suggests that generativist approach views semantic-compatibility effects as binary, rather than gradient (i.e., a given verb is either passivizable or it is not). Indeed, the minimalism view goes further than GB approaches in suggesting that the passive is not a special construction, but just another functional head, with a range of independent syntactic behaviours. The movement of the object into surface subject position; i.e., *Sue* from *John kicked Sue* to *Sue was kicked by John*, is motivated by the behaviour of the thematic subject (the necessity to have an AGENT in a single construction with functional head, as explained above for GB; *Sue was kicked*, but not just *kicked by John* is a grammatical string) and the single argument of unaccusatives (an additional assumption of Minimalism) – as a categorization of verbs as passivizable.

Though in general, LFG rules out most of the restrictions posited under GB and minimalism (i.e., binary cross-classification that leads to activation of the lexicon as described above), the LFG principle of "lexical integrity" maintains the passivization rule, in the form of a lexical rule that applies to the lexical entry. First, this rule allows, for the passive, the AGENT to be either not realized at all (e.g., *Sue was kicked*) or realised as an oblique element (the *by*-PP; with *by John*) – the necessity of AGENT (as mentioned above with regard to Minimalism). As also mentioned above (in GB), the object used of an accusative verb construction (passivizeable construction), 'must' become the subject in passive. (Müller, 2020: 232).

This emphasis on lexical rules still applies in HPSG, even specifying the change of case in passivization (i.e., movement of the Subject and Object position in passive construction). HPSG, however, reinstated the previously-ruled-out role of the lexicon (from LFG) in the passive transformation. While the HPSG approach suggests that unmarked order (nominative, accusative, dative) applies to the output of the passive rule, the passive rule itself does not mention the meaning of the verb, under the assumption that the passive rule is a "meaning preserving rule" (Müller, 2020: 289). Nevertheless, although under HPSG constructions themselves do not have

meaning, semantics plays an indirect role since the lexical entry for the verb requires linking between semantic and syntactic roles.

In summary, although very different in their detail, these approaches regard the passive as a wholly – or at least mainly – syntactic phenomenon. A particularly radical approach is that of Chomsky (1993) who argues that "constructions such as...[the] passive remain only as taxonomic artifacts, collections of phenomena explained through the interaction of the principles of UG, with the values of the parameters fixed" (Chomsky, 1993: 4). That is, the passive is viewed as a phenomenon that changes the number of arguments and position of arguments that a verb uses, as in *Sue was kicked by John*, where the theme appears in subject position and the agent is either mentioned after a preposition (*by John*) or can be omitted entirely (Carnie, 2013: 261). Although both active and passive describe the same event with the same participants (verb, agent, patient), since the passive construction uses an optional prepositional phrase (*by*-), the following agent can be considered as adjunct that can be omitted – hence, the structure of *Sue was kicked*.

In addition to the (broadly) Chomskyan accounts set out above, there are also several accounts that do not align entirely with a generativist view, but still considered the passive as essentially a semantics-free phenomenon. One such account is that of Branigan and Pickering (2017) which posited "a syntactic level of representation that includes syntactic category information but not semantic information (e.g., thematic roles) or lexical content" (Branigan & Pickering, 2017: 8). That is, "Syntactic representations do not contain semantic information". This view is different from Chomskyan accounts; indeed, they describe the theory as is "incompatible with 'mainstream generative grammar' such as transformational grammar, government and binding theory, and minimalist program (all Chomskyan approahces), where it assumes that the generative capacity of language is associated strictly with grammar" (Branigan & Pickering, 2017: 13). Branigan & Pickering (2017) assumed that initial abstract syntactic structure is altered sequentially through movement of elements (transformations) resulting in both logical form (syntactic representations that interfaces with semantic representation encoding sentence meaning) and phonetic form (sound-based aspects of the sentence). The semantics-free-syntax approach of Branigan and Pickering assumes "separate generative capacities for semantics, syntax, and phonology, and proposes that they are linked via interfaces, or mappings, that

involve input from the lexicon" (Branigan & Pickering, 2017: 14). For example, the passive construction *the girl was chased by the dog* would usually be analysed with syntactic representation of S [NP [Det N] VP [Aux V PP]], but, under Branigan and Pickering's account is seen in terms of shallower syntax; i.e., just S [NP VP], in which its NP has its own representation in NP [Det N] – with constraint of semantic, syntactic, and phonological representation on different linguistics levels. Although this view may seem similar to the analysis of HSPG through the use of lexicon, the differences lie in how Branigan & Pickering (2017) view lexicon as fragments of structure (syntactically), not through arguments and linking information (as in HSPG).

Another relatively formalist account that is nevertheless different to the generativist account is that of Culicover and Jackendoff (2005), which regards the passive not as an operation that deletes or alters parts of argument structure, but rather (like constructivist approaches below) as a structure in its own right; one that can be unified with other independent pieces of the sentence. The result of this unification is an alternative licensing relation between syntax and semantics (Culicover & Jackendoff, 2005: 203). This alternative licensing is realized in the use of Grammatical Function (GF) that refers to "the manipulation of semantic arguments in hierarchy and only applies to syntactic NP arguments" (Culicover & Jackendoff, 2005: 152) – e.g., Subject and Object. Semantics here is conceptualized in a relatively formal way (e.g., theta roles), rather than allowing for the more probabilistic semantic effects tested in the present. Indeed, the approach still allows for semantically empty "dummy subjects" (e.g., *It tends to be possible to leave early* or *There tend to be lots of people here*). GF is also best explained as the link of syntactic and semantic information in a construction (e.g., passive). The ranks to GF can be seen through the following hierarchy that is based on direct NP arguments and Conceptual Structure (CS) in thematic roles (Culicover & Jackendoff, 2005: 191)

> GF-tier: [Clause GF (> GF (> GF))]
> e.g., *John opened the door* → [CAUSE (JOHN [BECOME (DOOR OPEN)])] points out that *John* (AGENT) is the highest GF, *door* (PATIENT) is the second tier GF, and the whole clause is the third tier GF.

While this view clearly acknowledges the role of semantics, at the level of syntax-semantics mappings, this mapping operates without reference to the semantics of the verb in particular. Thus, the separation of thematic roles and the syntactic phenomenon here implies that the passive construction itself is semantic-free.

3.0 Constructivist/semantics-based accounts

This section presents a detailed view of constructivist accounts of the representation of the passive. Perhaps the most prominent constructivist account (Goldberg, 2005) posits that the passive, like other constructions, is a pairing of form and function that is learned from the input. Hence, the passive construction varies from language to language with regard to form factors such as the choice of possible auxiliaries (e.g. was or has), the presence of adposition (e.g. preposition on AGENT argument), possible semantic or discourse restrictions (e.g. when intentionally emphasizing the PATIENT), and the function factors on how the topic/agentive argument is essentially demoted as less prominent adjunct (e.g. how NP of Subject in active becomes less prominent in passive) or dropped altogether (Goldberg & Suttle, 2010: 472).

One of the motivations for this approach – relevant to the present thesis, which investigates passives across two typologically-unrelated languages – is that it offers a different explanation of crosslinguistic similarities in the passive construction to that offered by traditional generativist accounts. Where traditional accounts explain crosslinguistic similarities in terms of, for example, a global category of direct object, constructivist accounts explain crosslinguistic generalizations in terms of grammar-external factors such as universal functional pressures, iconic principles, and processing and learning constraints. Generally, constructivist accounts have argued that crosslinguistic generalizations can be explained better in terms of how form and functions tend to be linked across languages. For example, agents are – for functional reasons – always expressed in prominent syntactic positions, often SUBJECT. But in many syntactically ergative languages, agents are not generally expressed as subjects, and instead – for example – as oblique objects. Thus, crosslinguistic generalization is explained not by syntactic, innate stipulation, but by appealing to general cognitive mechanisms (i.e., the meaning of a certain verb that alienates from its literal meaning would need a consideration of pragmatics as well, or how it depends on the additional

consideration of context – as explained further in study 3). To take a broader example, the fact that all languages appear to have noun and verb categories may be explained by the existence of corresponding basic semantic categories (Goldberg & Suttle, 2010: 473).

Before moving on to consider specific constructivist/construction-based approaches, and their treatment of the passive construction, we first consider two general assumptions that are shared by all such approaches: (1) the view of syntactic structure consisting of symbolic units and (2) the existence of a complex network of constructions. It is important to acknowledge that although both word and construction can be seen as symbols, the notion of "construction" is usually reserved for clause-level units such as imperative sentences or subordinate clauses (Diessel, 2013: 347). Under such approaches, the mental lexicon is seen not as something quite separate from syntax (as under traditional approaches), but as originating from overlapping and contrasting features of construction-based symbolic expressions. A good example of the constructional network is the following map of semantic and structural relationships between verb-argument constructions in English (Goldberg, 1995: 109).

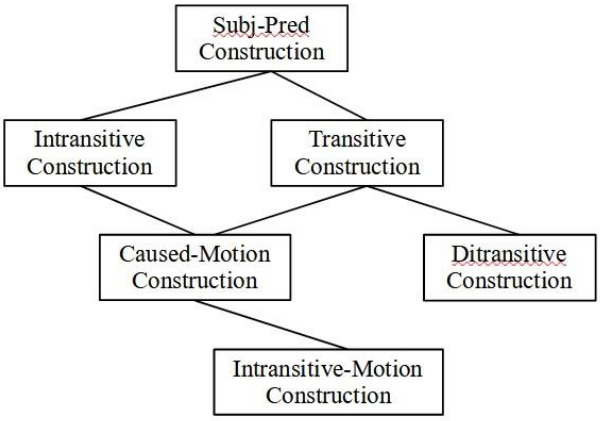

Figure 4. A partial network of English argument-structure construction (from Goldberg, 1995: 109)

As emphasized by Goldberg (1995), the constructicon (lexicon of constructions) contains everything that would be contained in a lexicon; but in addition, a large number of symbolic units that are larger in size than single words. The constructions

that speakers know are directly associated with phonological, morphological, and syntactic properties, along with conventionalized meanings, possible variants, and the social contexts in which we are likely to use and hear them. In the simplest of terms, "your knowledge of a construction is the sum total of your experience with that construction" (Hilpert, 2014: 3). In older versions of a construction grammar (e.g., Goldberg, 1995), to count as a construction, a unit of knowledge was required to have some element of form or meaning that was not predictable from the more general formal pattern (i.e., *by and large* or *all of a sudden*). But in more modern approaches (e.g., Goldberg, 2006), entirely predictable patterns can be constructions too. Thus, not just the passive, but also is the active, is seen as a daughter of a more general transitive construction; in all cases, these constructions are fully schematic, rather than lexically-specific.

What, then, are the functional semantics (as opposed to form) of the passive construction? As noted by Pinker (1987), successful comprehension is not a particularly useful diagnostic, since even adults can fail to comprehend legitimate passives (e.g., *The horse raced past the barn fell*) and can easily comprehend ungrammatical passives (e.g., *Shampoo is contained by the bottle*). In a forerunner of the construction-grammar approaches of Goldberg et al, Pinker (1987) proposed the idea of a thematic-core of a construction: the link between a syntactic predicate-argument structure (a set of grammatical functions used by a verb to express its arguments) and its thematic representations. For the passive (Pinker et al, 1987: 52), the proposed thematic core (as we have already seen above) is as follows:

> X (mapped onto the surface subject) is in a state or circumstance characterized by Y (mapped onto the by-object or an understood argument) having acted upon it. Thus, X is a theme of a circumstance, and a patient of an action (Pinker et al, 1987: 55).

In line with the LFG framework adopted, Pinker et al (1987: 56) set out subclasses of verbs that may undergo (or resist) passivization: First, all the subclasses of verbs that have actional patients obviously are compatible with the passive thematic core (5), including verbs in which the patient can be alternately construed as the entity caused to undergo a location change (6)

(5) Sue was kicked by John
(6) The book was moved by John

Second, if an action verb is to be passivizable but its subject and object are *not* the agent and patient in terms of physical motion, then they must be the agent and patient at some parallel level in the verb definition. For example, in (7) the verb *receive* can be construed as an "action" performed by an abstract agent (thus John is the agent rather than a goal), and the object as a patient (rather than a theme):

(7) The book was received by John

Third, both major subclasses of psychological transitive verbs in English passivize: "those like *please*, and those like *like*, with inverse linkages of experiencer and stimulus to subject and object".

(8) John was pleased by Sue
(9) John was liked by Sue

Fourth, "many verbs expressing abstract relations can also be seen as involving generalized agents and patients – verbs that ambiguously take humans or abstract propositions as causes"

(10) The new treaty was justified by John

Fifth, only some verbs of spatial relationships are passivized, some are not; the passivizable verbs denote a change of state that is compatible with the notion of a generalized patient:

(11) The street was lined by (/with) trees

As we will see in more detail below, although they reject both the class-based aspects of Pinker et al's (1987) account and the underlying (LFG) formalism, modern

constructivist investigations of the passive have generally adopted (and supported) Pinker et al's notion of the "thematic-core" of the passive; albeit reframed as the "meaning of the construction", rather than as a thematic core per se.

With this general constructivist overview in mind, we now move on to consider some individual constructivist/construction-based accounts, with reference to the passive construction: simpler syntax (SS), cognitive grammar (CG), sign-based construction grammar (SBCG), cognitive construction grammar (CCG), radical construction grammar (RCG), embodied construction grammar (ECG), and fluid construction grammar (FCG).

Simpler syntax in some ways straddles the boundary between more traditional syntactic analyses and construction grammar approaches. The general argument can be summed up as follows (from Culicover & Jackendoff, 2005: 6)

> given some phenomenon that has provided putative evidence for elaborate syntactic structure, there nevertheless exist numerous examples which demonstrably involve semantic or pragmatic factors, and in which factors are either impossible to code uniformly into a reasonable syntactic level or impossible to convert into surface structure by suitably general syntactic derivation.

Thus while, for example, the passive can certainly be understood as syntactic structure, semantic and pragmatic factors are relevant too. Under SS, the passive is formulated not as an operation that deletes or alters parts of argument structure (as under movement analysis), but rather – in common with other construction-grammar approaches – as a piece of structure in its own right that can be unified with other independent pieces of the sentence. That said, unlike other construction grammar approaches, and more like traditional formal approaches, SS assumes a Grammatical Function (GF) tier, which is similar to the f-structure used in LFG to refer to the syntax-semantics interface.

In the passive construction (e.g., *The door was opened by John*), the mapping of GF-tier in the active can be retained even if it 'requires' the removal of Subject. Since the Subject role is the highest rank in CS, the highest rank in GF, and the highest rank NP in syntax as well, the removal (and reappearance of the Subject) is enabled

through an argument that posits a link between the highest ranking GF (i.e. Subject) in the existing GF-tier and an oblique NP (i.e. the link between AGENT that is used in the following *by*-phrase), without disrupting the link between this GF and thematic roles. This is then followed by passive inflection of the verb (i.e. *-ed*) and adding a bracket (*by*- phrase) to the existing GF-tier. The passive construction thus appears as shown in Figure 5.

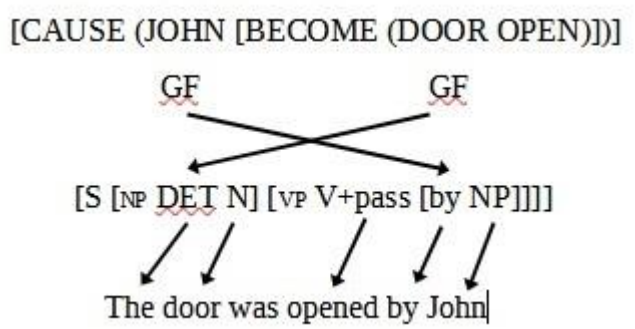

Figure 5. Passive construction in SS (Culicover & Jackendoff, 2005)

Cognitive Grammar (CG) approaches highlight how the passive can signal the speaker's focus on the patient rather than the agent in a construction. CG proposed that the key factor is the extent to which the *situation* provides motivation for the speaker to make one particular choice of subject over another. Standardly, that is, "for canonical active sentences, the situation is relatively clear cut: one participant is clearly more highly active than the other, and attention will be naturally drawn to the active one" (Langacker, 2008: 365), which appears as the active SUBJECT. In contrast, the passive construction:

> combines with a verb to derive a higher-level verb representing a different process type by adjusting the focal prominence of processual participants, conferring trajector status on what would otherwise be the landmark. These trajector alignment referred as agent orientation and theme orientation.

(to define our terms here, AGENT refers to the instigator of an 'active' action, change, or force and THEME to 'passive' settings, locations and stable situations. Arguments that do not meet either criteria are termed EXPERIENCERs).

In CG then, the passive is a "focused-theme" construction. Semantically, an indirect object is usually an experiencer, but in respect to agent and theme opposition, there are active (or initiative) and passive (or thematic) experiencer (Langacker, 2008: 392).

(12) Sue was frightened by John
(13) Sue was feared by John

An important factor in SBCG to emphasize, is the use of valence (VAL) in its framework as an attempt to further explain linking information (in HPSG) that represents syntactic-semantic argument in a construction. The use of VAL is meant to complete the task of argument structure of a certain word or category that may not be filled; i.e., a VP *kicked by John* would require a Subject in its VAL. Therefore, in the passive construction, the head input (i.e., V *kicked*) would require specifier (SPR) of either a subject (e.g., NP *Sue*) and complements (COMPS) of another NP (e.g., *John*) as an argument to the verb, in order to 'satisfy' the VAL requirement. VAL requirements are passed from daughter to mother until they are cancelled via satisfaction, i.e., the required sister (i.e., both SPR and COMPS) is supplied by phrase-building (i.e., NP) construction (Michaelis, 2006: 77). The difference between SBCG and HPSG though, is how SBCG takes into consideration various signs syntactically (i.e., phonology/form, argument structure, syntactic category, VAL, and feature marking), as well as trying to accommodate signs semantically (as under CG) and even contextually (Sag, 2012: 96).

A hallmark of Cognitive Construction Grammar (CCG) is that certain verbs are associated with specific lexical semantic information that allows them to integrate with the semantics of an argument structure construction, as in – for example – the caused-motion construction.

(14) John kicked the ball to Sue

This association is constrained by the "semantic coherence principle" that "only semantically compatible roles can be fused (e.g., the kicker participant of the *kick* frame may be fused with the agent role of the ditransitive construction because the kicker role can be construed as an instance of the agent role)" along with "correspondence principle" that each "lexically profiled and expressed participant role must be fused with a profiled argument role of the construction" (Goldberg, 1995: 50). However, this is of limited relevance to the passive, which is considered to be a more abstract construction that is comparatively less rich in meaning as it presents only a different perspective of an event. Whereas the caused-motion gives a "new meaning" to *kick*, which is not a caused motion verb, and famously, to Golberg's (1995: 50) example with sneeze

(15) He sneezed the napkin off the table

the passive construction does not so much give a "new meaning" but denotes a shift in perspective from the active (Boas, 2013: 236).

One main difference between CCG and other construction-based approach is its emphasis on psychologically plausibility: It seeks to determine how various cognitive principles serve to structure the inventories of constructions (rather than focusing on formal explicitness and maximal generalizations). Three core organizing principles of constructional knowledge in CCG are as follows.

(1) **Motivation for the cognitive principles** (as in Goldberg's, 2006, Subject-Auxiliary Inversion which sets out why, on the surface, very different constructions share Subject-Auxiliary-Inversion; the similarities are not predictable, but they are *motivated*).

(2) **Constructional taxonomies** (relations between constructions in a model of taxonomic network where each construction constitutes a node in the network that forms inheritance hierarchies; a continuum from the fully concrete to the highly schematic.

(3) **Productivity**: Constructions with higher variability – i.e., higher construction type frequency – are more predictable.

One way in which Radical Construction Grammar (RCG) is radical is its assumption that

> constructions such as the passive need not specify the linear order of their constituent elements; in many cases they do not, linear order being determined by other constructions with which they are combined (Croft, 2005: 274). This can be seen in the use of idioms (i.e., *kicked the bucket*), where constructions would be less schematic and more substantive – therefore, syntactic phrase structure rules are reinterpreted as maximally schematic constructions in the contemporary construction grammar. In RCG, however, constructions that include complex syntactic units, are the primitive elements of syntactic representation; grammatical categories as such are derived from constructions – there are no formal syntactic categories such as 'noun', 'verb', 'subject', or 'object per se.

RCG also assumes that the formal representation of constructions consists only of a (complex) construction and its component parts (dispensing with the traditional idea of syntactic relations between elements). It also assumes that all constructions are language specific; i.e., that there are no universal constructions (Croft, 2005: 276).

The passive constitutes a good example of RCG's rejection of the notion of syntactic categories. Consider 16-18:

(16) a. John kicked Sue
b. Sue was kicked by John
(17) a. The man walked with a cane
b. *A cane was walked by the man
(18) a. John weighs 180 pounds
b. *180 pounds is weighed by John

Following the active-passive construction pair in example 16, the oblique (*a cane*) used in 17a (a similar – active construction to 16a) requires a preposition (*with*) and cannot be passivized, as seen in 17b. Example 18a (another similar – active construction to 16a), however, does not require a preposition for the following *180 pounds*, yet also cannot be passivized (as seen in 18b). Thus, there is no way to posit syntactic categories (without references to particular constructions) that explain these facts. (Croft, 2005: 279). Under RCG, then, what are traditionally called "syntactic categories" are only derivable from constructions, and hence are not the basic building blocks of syntactic representation.

A second claim of RCG is the denial of syntactic relations: The argument is that many allegedly syntactic relations are in fact semantic, and that it is problematic to analyse what remains as syntactic relations. Croft (2005: 284) argued that "the representation of construction must specify its symbolic relations; the correspondence between elements of the syntactic structure with the appropriate components of its semantic structure, since without it, one would not be able to deduce the meaning of the utterance from its form" (Langacker, 1987: 76). In brief, the existence of syntactic relations best described as follows:

> If a hearer hears an utterance and is able to identify the construction form, its meaning, and the correspondence between the syntactic elements of the construction and the components of its semantic structure, then he will be able to identify the semantic relations between the components denoted by the syntactic elements. That is, the hearer will have understood what the speaker meant. Understanding the meaning of an utterance is the goal of communication. Syntactic relations are not necessary to achieve this goal (Croft, 2005: 284).

Consider again the example *Sue was kicked by John*. It can plausibly be argued that there is a semantic relation between the 1st singular referent (*Sue*) and the action (*kicked*), since she is being directly affected. However, in the sentence *Sue was seen by John* – which has the same syntax – the semantic relation does not hold; the relationship is more of a state. Semantic relations do the job, but syntactic relations do not. Furthermore, from the perspective of syntactic relations, "if there are three or more elements in a construction, then there will be four or more logically possible sets of

syntactic relations that hold between the elements. But there is only one semantic role representation for each construction, the one that indicates that each element is a part of the construction as a whole" (Croft, 2005: 290) – recall the problem indicated in the complexity of syntactic categories mentioned in TG.

A third claim of RCG is the denial of universal constructions: There is no single fixed set of syntactic properties that can adequately represent "the same" construction across languages (Croft, 2005: 294). For example, when looking at passives, the differences between active and passive constructions within a given language are different (as we will see when we contrast English and Balinese in Chapter 4). This is inevitable due to gradual syntactic changes seen for all constructions – each intermediate step in the process represents an intermediate construction type in structural terms. Moreover, these changes usually arise from multiple paths of grammatical change. These pressures mean that there is, cross-linguistically, a huge possible syntactic space for a given construction type (e.g., the passive).

The final two accounts to be considered here, Embodied Construction Grammar (ECG), and Fluid Construction Grammar (FCG) focus more on the mechanics of implementing construction-grammar into machine learning. Nevertheless, both still adopt the concept of form-meaning pairs found in other construction-grammar approaches. ECG views constructions as "components of the hypothesized set of mechanisms engaged by language users – each constructional form-meaning pair represents a hypothesis to be validated through observations of behaviour in natural and experimental settings" (Bergen & Chang, 2013: 169). The use of mental simulation and its representation in ECG are some of the most critical aspects of this approach. "Mental simulation in comprehension can be seen as how people drawing detailed, relevant inferences that are grounded in sensorimotor experience and sensitive to contextual conditions; words and other constructions serve as pathways connecting detailed, modality-specific knowledge about their forms with detailed, modality-specific knowledge about their meaning that both realized in categorization" (Bergen & Chang, 2013: 151).

This description established the relationship of mental simulation with word meaning that is the core principle of ECG. There are three classes that represent the syntactic-semantic link of constructions in ECG through how grammatical constructions can affect mental simulation. First, aligning meaning and constituents in

grammatical constructions can help constructional meaning (e.g., switching Subject and Object as in **The dog was barked by the man* can result in different mental simulation). Second, the contribution of categories of experience (schema) to mental simulation (e.g., *Sue was kicked by John* would invoke relevant events – play or accident, entities – a boy and a girl, and motion – movement of foot to Sue, even without any detailed explanation). Third, properties of simulation account for the "perspective or locus of attentional focus" (i.e., active sentences would provide simulation of events from the perspective of the AGENT, while passive provided simulation from the perspective of the PATIENT).

FCG can be considered as a "daughter" of ECG. It is an approach to the formalism of construction grammar in general; as long as the analysis adopts a constructional perspective, the approach allows for any conceptualization of argument-structure (i.e., of types of units or possible constructions). FCG emphasizes on an inventory of construction schemas that can be accessed via the constraints of comprehension (from form to meaning) and production (from meaning to form). Accessing these schemas in production can expand or stretch the grammar (i.e., to express new meanings); comprehension can require the system to fall back onto knowledge of semantics and context, if its construction schemas are inadequate (Steels, 2017: 186).

4.0 Studies with children: General development of the passive

In this and the two following sections we investigate the extent to which previous research supports the generativist and constructivist positions set out above. Broadly speaking, constructivist accounts predict gradual acquisition and semantic effects: passives will be easier and/or judged more grammatical when the subject is highly affected (Pinker et al, 1987). Because generativist accounts do not assume construction semantics – but that the passive is formed by some kind of transformation/lexical/movement rule – they do not predict such semantic effects; at least not straightforwardly. Rather, generativist studies tend to focus on demonstrating early competence, as evidence for the innate, or early developing, passive rule. Before focussing on the question of semantic effects with children (Section 5.0) and adults (Section 6.0), we first review studies that look at children's acquisition of the passive

– innate rules versus gradual abstraction – more generally. Although the focus of this thesis is adult representations, it is important to take a brief look at the data provided from studies with children, since they have implication for the adult endstate. Findings from these child studies can provide evidence of the *development* of adult representations. They are also (Section 5.0) a good way of testing for semantic effects, particularly as children may struggle to produce, or may make errors with passives that do not meet the affectedness prototype, whereas adults do not.

An early study of full passives was conducted by Horgan (1978) to test children's construction of passive sentences in reversible passives (e.g., *The dog was chased by the girl*) and non-reversible passives (agentive and instrumental)

(19) The lamp was broken by (or with) the ball (Instrumental)
(20) The lamp was broken by the girl (Agentive)

Despite the linguistic prominence of the passive, very few early studies focussed on the acquisition of passive *production*. This study involved experiments with 234 children aged 2;0 to 13;11, separated into two groups – the first group consisted of 54 children aged between 2;0 and 4;2, and the second 30 in each age group of 5, 6, 7, 9, 11, and 13, and 262 adults (college students). Using a picture description task, the findings showed that children mainly produced truncated passives (with deletion of the logical subject or agent) rather than full passives (e.g., *The lamp was broken*, rather than *The lamp was broken by the girl*). This finding was taken as an argument against the (then current) transformational grammar account of sentence construction via transformation from active to passive (Horgan, 1978: 68). Moreover, this finding also suggested that children's early conceptual knowledge of the passive is of marking states (as shown in the truncated passives; e.g., *broken*) than actives. Comparison between the child and adult data showed that the adults were able to produce larger number of reversible passives (both agentive and instrumental, equally). Therefore, aside from the claim that children have not fully acquired the semantics of passive until later, they also have their own preference for certain forms in their spontaneous speech; one which is not in full accordance with adult usage. This study was particularly important as a foundation for future studies showing that young children's representation of the passive is different to adults.

Another study that took a developmental perspective was conducted by Crain and Fodor (1993). The goal of this study was to test the claim of innateness in rules of passive formation, and was therefore conducted with particularly young children (20 children aged 3 to 5 – *M*=4;6). The study was built out on the foundation of other literature that focused on children's "performance errors". These errors or imperfect performances may not be an indication of children's lack of abstract grammatical representations, since there exist other relevant factors that hinder this performance. It was proposed that "children's performance is weak at first and improves with age in large part because of maturation of non-linguistic capacities such as short-term memory or computational ability, which are essential in the efficient practical application of linguistic knowledge" (Crain & Fodor, 1993: 119). Some of the experiments conducted were aimed at showing that these errors disappeared or were greatly reduced when confounding factors were suitably controlled for. In addition to other structures (relative clauses and *wanna* contraction), Crain and Fodor (1993) showed that, when certain felicity conditions are met, children are also able to produce utterances that exhibit essential full-passive structure (underlying subject in pre-verbal position; agent in post-verbal prepositional phrase). For example, by pointing out (e.g., *see...*) and giving instructions (e.g., *ask which one...*) to a description of an event, the experimenter can create a scenario such that the child will need to use full passive in order to obtain the desired answer (Crain & Fodor, 1993: 132). In contrast to the previous study that claimed to show clear differences between children's and adults' representations, this study shown that there is a degree of continuity, and that we can observe differences only after taking into account differences in cognitive and computational resources, as well as different exposure to the passive structure.

Another study focussing on the English passive, Israel, Johnson, & Brooks (2000), used corpus methods. The claim of this study was that acquisition can be described as a process whereby certain uses of a relatively simple source construction provide the basis for children's initial hypotheses relating to a more difficult target construction. One of the most significant findings in their study is how after producing the first statives participles (21), but before producing any unambiguous eventive ones (22), children regularly begin to use participles in equivocal contexts, where they can be interpreted either as stative or eventive (23)

(21) The spinach is cooked (stative)
(22) The spinach was cooked by Mommy (eventive)
(23) The spinach needs to be cooked (overlap)

Israel et al (2000) argue that stative is relatively easier to learn than the eventive participle due to the co-occurrence of the stative with the situation being described (c.f. *The spinach was cooked* vs *The spinach was cooked by Mommy*). This gradual development is argued to occur via "context bridging" through which "relatively abstract semantic-pragmatic properties can be associated with familiar formal patterns through a simple process of contextually motivated reanalysis" (Israel et al, 2000: 106) – i.e., when the early, simpler construction is more frequent than the target construction or relatively easy to demonstrate in the context of face-to-face interactions. Morphosyntactically, Israel et al (2000) argue, "children must learn that there is a participle construction in their language before they can learn the complex polysemy associated with that construction".

Focussing on the use of verbs in the passive construction, Brooks and Tomasello (1999) conducted experiments investigating how children's production of passive can be explained through newly-learned (i.e., novel) verbs. The study was concerned with three particular aspects of passive production: (1) appropriate exposure and training that can combat the low frequency of exposure to the passive, despite its complexity (2) children's ability at producing the passive construction with novel verbs, which tests whether acquisition proceeds verb-by-verb (individual meaning) or via a generalized construction, and (3) children's ability at using pronouns in both active and passive, which reflects their understanding of the relative prominence of agent and patient.

The first experiment was conducted by using two novel verbs with 56 children of two different age ranges (28 younger children aged 33 to 36 months, and 28 older children aged 39 to 44 months), and several different puppets and inanimate objects to enact the action. The results of this experiment suggested that children's production of sentences with novel verbs was aligned with the frequency of exposure they had during training: Active-trained children produced more actives and passive-trained children produced more passives with the novel verb. Intransitives were infrequently produced due to their absence in training. Also notable was children's tendency to resort to using

familiar English verbs when the construction trained using the novel verbs did not match the discourse demands (i.e., if the discourse required a passive, but the novel verb had been trained in the active only). Children's use of pronouns demonstrated that they are sensitive to the discourse demands of the construction they used (active or passive) and the questions they answered.

The second experiment was conducted in similar manner, but with 20 children aged 32 to 37 months, and with an emphasis on the use of discourse pressure to encourage children to produce passive constructions with the newly-acquired novel verbs. Through this method, children were able to produce more novel (newly acquired) verbs with passives (also indicating syntactic priming). Furthermore, the majority of children, even those who were not productive with the passive and active construction with novel verbs, showed sensitivity to the focus of the agent and patient-focused questions (Brooks & Tomasello, 1999a: 41). Thus, even if they are not productive with the passive with novel verbs, they seem to understand enough about its function to use pronouns appropriately in that construction, and it is abstract enough that it can be primed.

Syntactic priming, as mentioned above, refers to an increase in the likelihood of producing a sentence of a particular form (e.g., a passive vs active) as a result of recent prior experience with that form (Huttenlocher, Vasilyeva, & Shimpi, 2004). Huttenlocher et al. (2004) conducted three passive- (and also dative) priming studies with children (30 children aged 4;5 to 5;8 years for the first experiment; 30 children aged 4;2 to 5;7 years for the second experiment; and 30 children aged 4;1 to 5;7 years for the third experiment). Their first experiment found that children were more likely to re-use a particular sentence form (whether active or passive) to describe a picture involving different objects and actions after being exposed to the same form of a sentence that experimenter used and asked them to repeat it.

(24) Experimenter's Prime: the flower was watered by the rain
(25) Child' Target Sentence: the bunny was chased by the dog

The same result was found in their second experiment, which was conducted using a similar procedure to the first one; with the only difference that children were not asked to repeat the prime sentences (to better reflect the more common acquisition

occurrences of just listening to speech). The third experiment then tested the duration of this priming effect over time, using a set of 10 pictures. Indeed, children showed no decrease in the priming effect over time across these 10 trials. Although these results could be taken as evidence of early abstract knowledge (i.e., evidence for the generativist view) Huttenlocher et al (2004:192) argue that they show that "the abstract form needed to obtain priming effects may arise before the representation of syntactic structure is mature", consistent with gradual acquisition.

A similar study of children's structural priming was conducted by Savage, Lieven, Theakston, & Tomasello (2003) with 84 children divided into three age groups (3, 4, and 6 years old) and (in a second study) 20 children aged 4;0 to 4;7, using a similar method of picture-description, with a follow-up study (Savage, Lieven , Theakston & Tomasello, 2006) with 66 children aged 4;0 to 5;6 investigating long-term implicit learning as a result of the priming, The first study of Savage et al. (2003) was done by presenting cartoon animated scenes to the children followed by a description by the experimenter (repeated four times) – the *prime* – and then an elicitation of a *target* sentence from the child: a description of a different scene (prompted by '*What's happening?*', or '*What happened?*' Results from the first study (which included children's repetition of prime sentences) showed that lexical priming appeared with children aged 3 and 4 years (i.e., when both prime and target followed the form *It got VERBed by it*), but only children aged 6 years showed fully abstract priming; i.e., priming with no lexical overlap. This finding was corroborated further in a second study through replicating the first study but with only the 4-year-old children and the high overlap condition, but with no repetition of the prime sentence. Savage et al. (2006) then replicated the second study of Savage et al. (2003) and found that the use of varied primes was more effective than identical primes in eliciting passives. They also found a priming-persistence effect that indicates implicit learning. The finding of implicit learning here would suggest that priming – or sentence exposure more generally – can be seen as changing knowledge, or a means of acquisition, rather than just a method of indirectly accessing existing knowledge. Similar to Study 3 of Huttenlocher et al. (2004), Savage et al (2006) investigated the effect of priming effect over time, and also of systemic variation: using different numbers of verbs in the passive construction frame. They found that priming effects persisted for one month, but only for children who had reinforcement training after one week. They also found

that variation – i.e., more different verbs in the passive construction in the prime set – led to more priming and better learning. Although they do not specifically test semantic effects, both Savage et al (2003; 2006) provide evidence of gradual learning of the passive construction and hence for the constructivist view.

That said, different conclusions were drawn in a similar study conducted by Bencini & Valian (2008) to test the abstractness of the representation of the passive in young children (53 children aged 2;11 to 3;6). In contrast to the similar studies above, this study used a lexical warm-up phase to reduce the demands of lexical look-up, which the authors argued can mask children's abstract knowledge of the passive by introducing task demands. Analyses using both lax and strict coding of the results (excluding/including short passives) found that children indeed showed abstract priming of the passive. This claim was further supported by the small number of pronoun uses (in Savage et al, 2003, pronoun use was taken as evidence of less-abstract, lexical knowledge), and by the finding that following the passive priming, children were more likely to understand passives in comprehension. However, although the authors take their findings as evidence for early abstract knowledge, by comparing the first half and second half of the trials, some evidence of learning was also found. Nevertheless, the authors argue that children at this age have syntactic representation of subject and object, semantic representation of agent and patient, category representation of verb, abstract sentence-level representation, as well as the ability to flexibly map syntactic and semantic levels (Bencini & Valian, 2008: 111).

A third set of production-priming studies of the passive by children was conducted by Messenger, Branigan, & McLean (2011). The study was designed to investigate the claim that by the age of four, children have abstract representations of both the short and full passive. It is important to note that this finding would contradict Horgan's (1978) findings on the ability children age to produce full passives. Messenger et al (2011), like Crain and Fodor (1993) argue that children's infrequent use of the full passive may be attributable to the infrequency of felicitous contexts in English. In most cases, a short passive (26) meets the speaker's communicative goals (saying what happened to the patient) and it is not necessary to use a full passive expressing the agent (27)

(26) The girls are being shocked (short passive)

(27) The king is being scratched by the tiger (full passive)

The experiment in this study was based on the hypothesis that full-passive syntactic representation can be evidenced if, when hearing a short passive, children are primed into subsequent production of the full passive. That is, "they apply common abstract representations to both passive forms" (Messenger et al, 2011: 269). Using a similar picture-description method as for previous studies with 16 children aged 3;4 to 4;10, the authors indeed found higher rates of production of full passives after hearing short passives as compared to actives. Another important, and potentially surprising, finding to note from this study is that children produced a greater proportion of passives than did adults, due to the children showing greater susceptibility to priming. This is consistent with studies showing stronger priming in less competent or less experienced language users, such as second language learners (Flett, 2006). In summary, this study provided striking evidence of at least some degree of abstract (syntactic) representation of the passive at a relatively young age. Nevertheless, the key test for generativist versus constructivist accounts is really whether children (and adults) show evidence of semantic effects, which would provide evidence of a semantics-based prototype construction (rather than generativist transformational/movement rules).

5.0 Studies with children: Investigating semantic effects

Although not always entirely focused on semantic effects, a number of previous studies have found evidence that relates to the claim that the passive construction has the meaning of semantic affectedness, as mentioned in section 3.0 of this chapter: "the passive subject is in the circumstance characterized by having been affected by an action instigated by an agentive oblique object" (Pinker et al, 1987: 250). At one extreme, "English, in particular, has a set of semantically-cohesive classes of nonphysical verbs for which the thematic roles of agent and patient are defined more abstractly" Pinker's emphasis was on delineating classes of verbs that are and are not passivizable, in a binary sense (e.g., **£5 was cost by the book*). Our focus here, however, is on verbs that *are* passivizable, but for which the resulting passive is rated as less grammatical, or causes some difficulty in production or judgment studies. Although the most relevant studies for the purposes of this thesis, which focusses on

adults, are adult studies (Section 6.0), child studies are again informative because children may make errors with the less "affecting" passives, whereas adults do not. Therefore, investigating child development can be informative for the adult endstate. Although many of the child studies, particularly the early ones, see the semantic affectedness restriction as a "limitation" or "problem" with children's early grammars, comparison with adult studies (Section 6.0) suggests that it might actually just reflect the same semantic constraint that we can see in adults (possibly in more extreme form).

One early study, Maratros, Fox, Becker, & Chalkey (1985), investigated this semantic restriction on children passives. The possibility investigated in this study was that children would consistently have poorer comprehension of passives that used mental or nonactional verbs (i.e., *liked*) compared to action verbs (i.e., *kicked*). It is important to note that all of the mental, nonactional verbs in this study (e.g., *Sue was liked by John*) were experiencer-theme verbs, not the more action theme-experiencer type (e.g., *Sue was frightened by John*). This study compared these mental, nonactional verbs against agent-patient verbs (e.g., *Sue was kicked by John*) with the same subject and object roles. The first experiment with 38 children (aged 4;7 to 5;6) used 4 action verbs and 8 mental verbs in both actives and passives (with a total of 102 sentences). This was followed by questions regarding the subject or the object, designed to test understanding of actives and passives respectively. This revealed that action-verb passives were much easier to understand than experiencer-theme mental-verb passives (Maratsos et al, 1985). It is important to note that the agent-patient/mental verb difference did not appear significantly for active sentences, which means that these verbs are a reliable testing ground for passives (i.e., it is not that children fail to understand experiencer-theme mental state verbs altogether).

In a second experiment with 80 children (five different age groups – mean ages 4;5, 5;4, 6;10, 8;10, and 10;10), 6 action verbs and 6 mental-state experiencer-theme verbs were used in both actives and passives (a total of 72 sentences) in picture-description trials. Incidentally children showed higher rates of correct responses than in Study 1, suggesting that a picture-description method can be a better method for revealing children's knowledge than comprehension questioning. In this second experiment, it was clear that children are far better with action-verb passives than mental-verb passives experiencer-theme passives (but again not actives). That said, the authors did find that the least-portrayable activities (in pictorial representations)

relating to mental verbs (e.g., *like*, *love*, *hate*) yield worse performance compared to other mental verbs (e.g., *see*, *hear*, *remember*), highlighting the importance of controlling for overall verb difficulty (e.g., by using active). It was also found that even with practice with these mental verbs, performance can still be exceedingly poor; though accuracy improves if mental verbs are mixed in with actives, or with the clearly-understood action-verb passives (Maratsos et al, 1985: 184), In general, via differences found between verb types, this study provided strong evidence for the idea of a semantic affectedness constraint on the passive (Pinker et al, 1987), although these authors took this as a child deficit, that disappears when knowledge of the passive becomes more abstract.

A similar study of different types of verbs in the passive construction was conducted by Sudhalter & Braine (1985). Although this study refers to mental or nonactional experiencer-theme verbs as "experiential" verbs, the classification and hypotheses remains the same to Maratsos et al (1985): that "children find passive sentences easier to decode when actional rather than nonactional verbs are used" (Sudhalter & Braine, 1985: 456). One notable difference with this study is that it attempted to look for verb-by-verb differences within the categories of actional and experiential verbs, possibly due to verb frequency or morphological regularity). In the first experiment, with 76 children (27 children with mean age 6;5, 19 children with mean age 7;9, and 30 children with mean age 10;9), 12 experiential and 4 actional verbs were used in a question-answer format ("whodunnit" task) with oral stimuli. For example, experimenter read the sentence *John forgot Sue* and then asked two questions; '*Which one forgot the other?*' and '*Which one forgot?*' Children were then asked to circle the name on an answer sheet. In addition to replicating Maratsos et al's (1985) findings of better performance for actional than experiential verbs in passives, it was found that comprehension does not seem to vary as a function of verb irregularity or verb frequency. Indeed, there were no significant differences in comprehension scores between subcategories of experiential verbs: i.e., affective (e.g., *like*), perceptual (e.g., *see*), and cognitive verbs (e.g., *know*)

In an effort to figure out which improvements in cognitive process allow for better comprehension of passives with developmental age, Sudhalter & Braine (1985) conducted a second study. In this second experiment, 50 children (25 children aged 4 to 5 years, and 25 children aged 5 to 6 year) were asked to demonstrate comprehension

of passives by choosing between two options of stuffed toy animals from 48 trials that comprised of 6 actional and 6 experiential verbs. In the procedure, the child heard a sentence; i.e. *The orange owl believed the Wally* Gator, and then commanded '*Pick up the animal which believed the other*' and '*Pick up the animal which believed*'. In relation to the issue of children's developing attention, the results suggested that comprehension of actional and experiential passives is not an all-or-none process; children show partial competence that is consistent with their error pattern when producing passives. It is important to note that this partial competence is shown in erratic interpretation, which may signal a fluctuating attention mechanism; and it may be attentional improvements that lead to better performance with development. Nevertheless, overall, the findings of the study support the general account of "semantic affectedness" (Pinker et al, 1987), though again this is portrayed as immature restricted knowledge rather than (as we see in Section 6.0) a pattern shown by adults too.

Another study that investigated verb-semantic effects in children's passives was conducted by Gordon & Chafetz (1990), with a slightly different approach: Previous studies focused on verb semantics at the class level, while this study used a verb-by-verb approach, and also looked at frequency effects. First, the authors used the CHILDES corpus database (MacWhinney & Snow, 1985) to extract passives in children's input, and found that most of the passives in the input are short passives, and that these "short passives were used for obviating mention of a vague, unspecified agent" (Gordon & Chafetz, 1990: 235) They also found that, whether short or long, actional passives were much more frequent than nonactional passives (e.g., *John was seen by Bill*) in the input.

The second study looked for verb-by-verb patterns: I.e., if children show good comprehension with a particular verb in one session, do they show good comprehension of that particular verb (as opposed to the class of verbs) when tested in a retest later. In the study, 30 children (15 younger children aged 3;0 to 4;2 years old and 15 older children aged 4;2 to 5;6 years old) were asked to affirm or deny simple questions concerning both actors in a picture. The experiment used a set of 9 actional verbs (*drop, eat, carry, kiss, hold, wash, shake, hug, kick*) and 9 nonactional verbs (*watch, forget, hear, know, remember, believe, like, see, hate*), used by the experimenter in a short story description. Two sets of questions were asked, testing

comprehension of actives (e.g., *Did John hate the peas?*) and short/full passives (e.g., *Were the peas hated (by John)?*) asking the children to produce a yes/no answer. Results found that children did seem to show verb-by-verb consistency, though this was sometimes masked by improvement from the test to the re-test (suggesting that some generalization might have occurred during the task itself). In contrast to the studies above, and to the adult studies discussed below, these authors found no correlation between passive performance and verb-by-verb "affectedness" ratings obtained from adults. However, note that since non-actional verbs received uniformly low affectedness ratings, they were excluded from the correlational analysis. If they had been included, it is likely that a correlation would have been observed.

The first study looking at "typicality effects" as potential evidence for a semantics-based approach to the passive (other than Gordon & Chaftez, 1990; discussed above) was conducted by Meints (1999). This study defined the prototype of the passive as a graded structure that uses a canonical action event and treat other kinds of passives as peripheral members. The prototype passive was defined in terms of the typicality of agent, patient, and action. The semantic, pragmatic, and conceptual factors in this study involved focus, reversibility, affectedness and animacy of agent-patient, as well as transitivity. These factors resulted in the use of five criteria: actionality, result, punctuality, direct contact, and intentionality (Meints, 1999: 71). That is, a prototypical passive was defined as meeting the following criteria:

(1) affected, animate or inanimate, focused patient,
(2) action that incorporates high degree of action, punctuality, direct physical contact, shows a visible result, and
(3) acting, animate, defocused agent.

Meints (1999: 72) used these criteria to set out a prototypicality hierarchy, and predicted that the passive should be acquired in this order by children (see Table 1):

Table 1. Prototypicality hierarchy (Meints, 1999: 72)

Prototypicality	*PATIENT (FOCUSED)*	*ACTION*	*AGENT (DEFOCUSED)*
high	highly affected	**action group 1** **(high typicality of action)**	highly affecting
high to medium	medium affected	**action group 2** **(medium typicality of action)**	medium affecting
medium to low	medium affected	**action group 3 (adj.)** **(medium-low typicality of action)**	medium affecting
low	least affected	**action group 4** **(low typicality of action)**	least affecting

A series of production and comprehension tasks (full methodological details are not given in the original paper) found that children aged 2-4 did indeed show evidence for this prototypicality hierarchy for passives. This is consistent with Pinker et al's (1987) affectedness constraint: the higher affectedness of the patient, the higher the scores on the action group factors, and the more affecting force of the agent increases, the more prototypical the passive sentence should be. In other words, this finding demonstrates the gradient, hierarchical nature of semantic effects of affectedness for the passive construction. Again, however, this study sees affectedness as something that affects the order of child acquisition, rather than (necessarily) a factor that is important in defining the adult representation of the construction.

Messenger, Branigan, McLean, & Sorace (2012) conducted the first syntactic priming study designed to test the claim of a semantic constraint on the passive construction (as found by Maratsos et al, 1985; Sudhalter & Braine, 1985). This study was an advance on previous studies in that it used two different categories of nonactional verbs: experiencer-theme (e.g., *see, hear, like,* as in previous studies) and theme-experiencer (e.g., *scare, frighten, annoy*). Messenger et al (2012) also suggested that children's previous poor performance with experiencer-theme passives in comprehension/picture matching tasks might be due to task difficulties; i.e., difficulty in distinguishing the pair of pictures, which is straightforward for action verbs (e.g., *hit, kick*) but not for experiencer-theme verbs (e.g., *see, hear*). Supporting this view, Messenger et al's (2012) own picture matching study with 20 children aged 3;1 to 4;11 and 20 adults (mean age 21;6) found worse performance for experiencer-theme than theme-experiencer/agent-patient verbs, but equally so for passives and actives.

In order to solve the difficulties of picture-matching comprehension tasks, the main aim of this study was to investigate syntactic priming effects involving passives

of the agent-patient, theme-experiencer, and experiencer-theme type. This can indicate whether children's syntactic representation of the passive is semantically constrained (again, this study views a semantically constrained – as opposed to "abstract" – passive as an early immature state, not a characteristic of the adult grammar). If children's knowledge is indeed "abstract", in this sense of NOT semantically constrained, then all verbs should be equally good at priming children to produce passives. The semantic account would seem to predict that children will show priming of passive target responses (all using agent-patient verbs) following agent-patient verb and theme-experiencer verb passives, but not (or at least a reduced effect) following experiencer-theme verb passives.

Using, as the priming method, a variation of the children's game "snap", the first priming experiment was conducted using 24 experimental items (half agent-patient primes, half theme-experiencer primes). The second experiment then tested the priming using theme-experiencer verb and experiencer-verb passives (in both experiments, children's target sentences always used agent-patient verbs). Both studies were conducted with both 24 children aged 3;4 to 4;11 and 24 adults (mean age 18;8 years old). In both studies, for both children and adults, priming did not differ significantly across the two verb types, which led the authors to conclude that children's syntactic representation of the passive is not semantically restricted to agent-patient and theme-experiencer verbs, but is also generalized to experiencer-theme verbs. However, as we will explore in much more detail in Chapter 3. Messenger et al's study was apparently under-powered to detect by-verb-type differences in passive priming. A follow-up study by Messenger (2021) provided further evidence of abstract priming for 4-year-olds (and that the effect persisted into a test phase in which no more passives were presented), but is not directly relevant here, since it did not manipulate verb semantics (all verbs were of the agent-patient type).

A subsequent study conducted by Bidgood, Pine, Rowland, & Ambridge (2020) suggested a middle ground between claims of full abstractness and of a semantic affectedness prototype: it is not one or the other but both. This account claimed that "children's knowledge of the passive is both abstract and semantically constrained at the same time" (Bidgood et al, 2020: 3); in the sense that unwitnessed verbs can be used in the construction, provided they meet some minimum threshold

for semantic compatibility (implying the existence of a semantic constraint). Although the study used a similar method overall to that of Messenger et al (2012) several modifications were made to increase the probability of observing any underlying disadvantage of experiencer-theme compared to theme-experiencer/agent-patient passives. In the experiment that used force-choice comprehension task, pictures were replaced with animations to reduce any difficulty in illustrating the verb (particularly the case for experiencer-theme verbs). In the experiment that used production priming, the verb-type of the target verb (i.e., the verb that the child should use) was varied, rather than (in Messenger et al, 2012) the prime verb. This was to allow for testing of the prediction that children will actually produce more passives for (rather than just be more primed by) agent-patient (e.g., *kick* in *John kicked Sue*) and theme-experiencer (e.g., *scared* in *John scared Sue*) than experiencer-theme verbs (e.g., *ignore* in *John ignored Sue*).

The results of the force-choice comprehension task with 60 children (4 and 6 years old) and 60 adults, showed that the disadvantage for passives compared to actives was (unlike in Messenger et al, 2012) greater for experiencer-theme verbs than for agent-patient and theme-experiencer verbs, for both children and adults. It can be concluded that although this pattern does not constitute evidence against children's abstract knowledge, it does constitute evidence that children's – and adults – representation of the passive does seem to constitute a semantic affectedness prototype in some sense. Echoing this conclusion, in the production priming study, fewer passives were produced for experiencer-theme verbs than for agent-patient and theme-experiencer verbs. At the same time, an overall priming effect (more passives were produced following passives than actives primes) provides evidence for abstract knowledge.

A very similar production-priming study was conducted by Ambridge, Bidgood, & Thomas (2021) that extends the methodology to children with Autism Spectrum Disorder (ASD), as well as a control group for Typically Developing (TD) children. The broader aim of the study was to investigate the possibility that, in ASD, syntax itself is spared, and the communication difficulties experienced are caused by impairments in other areas of languages, such as vocabulary, semantics, socio-pragmatics, and narrative. In a production-priming experiment with 15 children aged 6 to 9 years, actives were not used, to focus on eliciting passives, and in particular

reversal errors, which are a hallmark of ASD (e.g., saying *Sue was kicked by Bill*, when in fact Sue kicked Bill). For our purposes, the most relevant aspect of the study was that semantic verb class was also manipulated by means of the familiar three types: agent-patient, theme-experiencer, and experiencer-theme verbs. In line with previous studies, findings showed worse performance (i.e., fewer correct passives) with experiencer-theme verbs Incidentally, this pattern was observed for both ASD and TD children, though the groups differed as to what they did when they did not produce a target experiencer-theme passive: TD children tended to produce correct actives, while ASD children tended to produce reversal errors (a finding replicated by Jones et al, 2021 with another 13 children with autism aged 6 to 9 years).

Finally, Nguyen and Pearl (2021) conducted a meta-analysis designed to summarize verb semantic effects on the age-of-acquisition of different verbs in the passives. All of the studies that measured "affectedness" have already been reviewed above, although for the purposes of the meta-analysis, this was coded as a binary predictor (+/-) rather than for degree of affectedness. They found, broadly speaking, that (many) agent-patient passives (e.g., *carry, drop*) were acquired by 3 years, theme-experiencer passives (e.g., annoy, frighten) by 3-4 years and experiencer-theme passives (e.g., *hate, like)* by 5 years. The authors then further tested this prediction using a truth value judgment task. In the procedure, the participant watched stories narrated by the experimenter with the use of animated clips, and the experimenter then gave a summary of the story in the form of a Test Sentence (e.g., *Isabelle was love by Jake*). As predicted, 4-year-old children were broadly speaking above chance for the agent-patient and theme-experiencer type verbs, but not experiencer-theme (*spot, forget, love, believe*). Again, though, the focus was on verb semantics with regard to the passive as a developmental trajectory, rather than a constraint that potentially operates in the adult grammar, as we now explore.

6.0 Studies with adults

As for the child studies above, we first summarize adult studies that have investigated the passive more generally, before turning to those that specifically investigate effects of verb semantics. Nevertheless, these studies do have implications for adult representations of the passive, and the level at which this can be said to be abstract.

The majority of these are syntactic priming studies, which find that hearing a passive sentence increases the likelihood of subsequently producing a passive sentence. In a review by Pickering and Ferreira (2008), the possible implications of structural priming as a method to examine syntax representation was emphasized (though in this review, syntactic priming was referred as "structural priming," since abstract linguistic priming does not need to be syntactic (Bock et al, 1992) nor involve perseveration (Smith & Wheeldon, 2001)). Extensive research using a priming paradigm to investigate passive in adults have provided evidence for both formalist/generativist and lexicalist/functionalist approaches.

An early classic experimental demonstration of priming was conducted by Bock (1986) when investigating syntactic persistence in language production. The first experiment in this study was conducted with 48 adults using a picture-description procedure, and found that syntactic repetition occurred even when there are differences in word order and grammatical roles that expressed two semantically comparable messages (e.g., active-passive and prepositional-double object dative).

Bock's account suggested that "sentence formulation processes are somewhat inertial and subject to such probabilistic factors as the frequency or recency of use of particular structural forms" (Bock, 1986: 1). The priming effect observed was equal in both directions (i.e., both prepositional and double-object datives and vice-versa).

(28) Double-object Dative: A rock star sold an undercover agent some cocaine →
Prepositional: An undercover agent sold some cocaine to a rock star

(29) Active: One of the fans punched the refer →
Passive: The referee was punched by one of the fans.

In a second experiment, it was found that this repetition effect persisted across variations in the message – "the development of sentence surface form occurred somewhat independently of relationships between messages and structural features" (Bock, 1986: 373). That is, the priming effect still held when the conceptual overlap between prime and target was reduced by manipulating animacy of the agent:

(30) The floors are cleaned by a janitor daily → Spring vacation was ruined by a blizzard

This second experiment was then replicated in a third experiment which included an interleaved recognition task to ensure that participants really were paying attention to the prime. In general, similar priming effects were observed across all three studies. Although not a direct test of a generativist versus constructivist accounts, the fact that priming is seen across sentences with so little overlap is consistent with a very abstract representation of the passive, at least in adults.

A similar study that applied the principle of syntactic priming to (unusually) corpus research was conducted by Estival (1985). The scope of the study was not only in lexical priming (choices of active-passive) but also involves semantic priming: choices between the lexical passive that has a stative interpretation and a "transformational" passive that is dynamic (p.9)

(31) John is interested in music (stative) (c.f., music interests John)
(32) John was believed to have left (transformational) (c.g., X believed John had left).

This corpus study found that a priming effect was observed in spontaneous discourse too. Importantly, like in the experimental study of Bock (1986) a strong priming effect was found even when the data contain no instance of repetition of a verb. Indeed, both Bock (1986) and Estival (1985) highlighted the extent to which, regardless of the lexical identity verb used, priming effects still hold even when the verb in prime and target sentences are semantically unrelated. Therefore, at least for adults, these studies provide no evidence of a lexical element to passive representation – it seems to be purely syntactic.

Several priming studies of syntactic roles have gone even further to attempt to rule out non-syntactic factors in priming, and therefore on language representation. One particularly famous study (Bock & Loebell, 1990) found that a priming effect holds even the prime and target do not share metrical (i.e., stress) or conceptual overlap. In Study 2 (Studies 1 and 3 were on datives) they found that participants could be primed to produce passives (33) by other passives that are very different in terms of the events, the agents and patients, and the stress patterns (34)

(33) The 747 was alerted by the airport's control tower (target)
(34) The construction worker was hit by the bulldozer (passive prime)

Furthermore, the passive was primed by sentence that are not passive at all, but that just share some overlapping syntactic structure (e.g., [NP] was [VERBed] [PP by [NP]):

(35) The construction worker was digging by the bulldozer (locative prime)

This would seem to rule out altogether a role for semantics in the passive construction, as the overlap of the prime and target share, according to Bock and Loebell (1990), nothing but syntactic structure. That said, in a large online replication, Ziegler, Bencini, Goldberg and Snedeker (2019) found that this more abstract type priming disappeared when the locative prime did not include the word *by*:

(36) The construction worker was digging **near** the bulldozer (prime)

This raises the possibility that the priming effect was driven at least partly just by the word "by". Ambridge (2022) raised another objection to Bock and Loebell (1990):

> let's take a moment to look at the actual numbers, or at least the percentages: Following passive and locative primes, participants produced 79% and 80% passives (21% and 20% actives) respectively. Following active primes, participants produced 74% passives (26% actives). OK, so 74% is significantly less than both 79% and 80%. But 74% is a *staggeringly* high rate of passive production… Can you see where I'm going with this? *Participants were consciously aware that the study was about passives, and that they were supposed to produce lots of passives.* So much so, that they produced passives at around *100 times* the usual rate, even when "primed" with actives. Given this context, it is hardly surprising that sentences which share some superficial overlap with the passive – such as the presence of *by* – boost passive production further (and, even then, only by 5 percentage points).

Nevertheless, in addition to thematic role differences, another study by Bock, Loebel, & Morey (1992) also found that syntactic priming persists even when controlling for animacy by reversing the agent and patient, and therefore the animacy of the roles:

(37) Five people were carried by the boat (animate subject)
(38) The boat was carried by five people (inanimate subject)

In the priming experiment with 192 adults, participants were exposed to picture-description followed by a recognition task (affirmation or refutation). They found that the priming effect was unaffected by the mismatch of the subject-arguments. Thus, this study ruled out this animacy effect for syntactic priming. Potter and Lombardi (1998) also found effects of syntactic priming in sentences that attempted to rule out syntactic-role priming, though since this study was on datives and not passives, we do not discuss it in detail here. However, it does show the robustness of priming since priming occurred both when the prime itself had just been recalled and when it had only been perceived.

Indeed, although some of the studies discussed above claim to have ruled out an animacy effect for syntactic priming (e.g., Bock et al, 1992), a recent study conducted by Buckle, Lieven, & Theakston (2017) did find some evidence for this effect, though with an effect of developmental change (This study investigated datives, not passives, though is still relevant for the question of the abstractness of adult priming). Through experiments with three different age groups – 46 children aged 3 years, 48 children aged 5 years, and 48 adults, the study found that while all groups showed a structural priming effect, an interaction of syntactic structure, animacy-semantic role, and prime-target match was observed. This interaction showed no animacy effect for adults (neither animacy word ordering nor animacy-semantic role mapping influenced adults target sentence). In spite of this, a different result was found for the two child groups, where an animacy effect was found. Therefore, the process where animacy cues affect speaker word order independently of syntactic structure is subject to developmental changes. Most importantly for our purposes here, the priming effect seems to be completely abstract – i.e., independent of animacy – for adults.

Perhaps the strongest argument for priming revealing an abstract level of passive syntax is the study of Hartsuiker, Pickering, & Veltkamp (2004) which looked at priming across languages. The study was designed not directly to look at semantic effects, but at bilingualism: do bilinguals stored syntactic information of each language separately (separate-syntax account) or is there some syntactic information shared between the languages (shared-syntax account). The priming experiment was conducted with 24 native Spanish speakers, who had lived in UK on 22 months average, and thus were also good English speakers. The priming was conducted using a picture-description method, followed by participants affirmation or refutation regarding the description (i.e., does it match the picture?) but across languages:

(39) The ship is sailed by the captain → El camión es perseguido por el taxi ('The truck is chased by the taxi').

Overall, this study provided two interesting findings to be investigated further: First, the occurrence of code-switching during experiment showing simultaneous activation of concepts – equivalent nouns – in both languages (such cases can be easily observed in live interpreting). Second, and relevant for this thesis, a cross-linguistic passive priming effect occurred, although with two moderately similar languages. This similarity (i.e., word order – the use of *by*- phrase in passives) means there is still a question of exactly how "abstract" this priming is necessarily.

Recall from the previous section that similar effects have also been observed for children (Bencini & Valian, 2008; Crain & Fodor, 1993; Huttenlocher, Vasilyeva, & Shimpi, 2004; Messenger, Branigan, &McLean, 2011; Savage, Lieven, Theakston, & Tomasello, 2003, 2006). Taken together, these studies create the impression of a major role for abstract syntactic forms in priming, and therefore in the representation of the passive construction. But it is important to understand that this evidence "should not be taken to mean that only abstract syntactic forms cause priming" (Pickering & Ferreira, 2008: 431). And, as we have seen, there is some evidence that even "purely abstract" priming may have a lexical element (e.g., by; Ziegler et al, 2019).

On a methodological note, a recent meta-analysis study of syntactic priming, Mahowald, James, Futrell, & Gibson (2016) analyse various studies (73) from the years 1986 to 2013 and found that, on average, most studies are underpowered.

However, they did find a large overall effect of priming, and this increased when the verb is the same at prime and test (a "lexical boost"). Future studies that use priming are recommended to start by estimating the size of the expected effect based on moderators (i.e., whether or not there is the possibility of a lexical boost; which construction is being used) and therefore calculating a sample size appropriate to the task. For example, the Bock and Loebell (1990) study was found to be underpowered, compared to its replication (Ziegler et al, 2019). However, it was also suggested to only use modestly sized samples to investigate whether some particular factor (other than lexical overlap, which leads to large effects) significantly affects the size of the syntactic priming effect, as very large samples can overestimate effects (Mahowald et al, 2016: 18). We follow these recommendations in our own replication of Messenger et al (2012) – see Chapter 3 – and our study of passives in a new language, Balinese (Chapter 4).

7.0 Semantic studies (adults)

With regard to the previously mentioned studies above, although they were generally not conducted with this aim in mind, each of these studies brings some evidence on the formalist/lexicalist versus functionalist/constructivist debate for passives. There have been, however, a number of studies that specifically looked for semantic effects and thus are of significant relevance for this thesis.

A study that looked at semantic effects on the passive, although somewhat indirectly, was conducted by Ferriera (2003). Participants (63 adults) listened to sentences and then were asked to identify the agent (or "do-er") – a thematic-role assignment task. For possible but implausible passives (e.g., *The dog was bitten by the man*) participants were more likely to make agent-assignment errors (e.g., saying that the dog did the biting) than for more plausible passives. Importantly, though, the effect was not observed for actives. Although processing mechanisms are clearly important, the findings are also compatible with a role for semantics: the passive is harder to process when it cannot plausibly be analysed as PATIENT being acted upon by an AGENT in a stereotypical/plausible way.

Following that result, an adult priming study was conducted by Christianson, Luke, & Ferreira (2010) to replicate the previous study by Ferreira (2003) using the

same sentence materials, but a different method: syntactic priming (see previous section) In an experiment with 75 adults, passive primes led to more passive sentences in the plausible condition (e.g., *The cheese was eaten by the mouse*) than the implausible condition (e.g., *The dog was bitten by the man*). Also, implausible actives (e.g., The cheese ate the mouse) primed passives (e.g., *The dog was bitten by the man*), presumably by priming a PATIENT-AGENT order. Again, this provides (although slightly indirect) evidence for the role of semantics: Only a passive with prototype semantics – a prototypical PATIENT being affected by a prototypical AGENT (or even a PATIENT-AGENT active) primes other passives. It also calls into question the conclusion of some of the priming studies above that priming is exclusively syntactic rather than working on the basis of semantic roles such as agent and patient.

The first study to look specifically at semantic effects for adults' representation of the passive (as opposed to solely or mainly developmentally) was conducted by Ambridge, Bidgood, Pine, Rowland, & Freudenthal (2016). In line with a semantic account of adults' constructional knowledge more generally (e.g., Goldberg, 1995; Pinker, 1989), this study proposed that the representation of the passive *in adults* contains this notion of semantic affectedness (Pinker et al, 1987), in the form of a semantic gradient of "passivizable" sentences (though without positing "movement") sentences. This study included two important methodological innovations that are adopted in this thesis: (1) the use of a semantic ratings task to capture the nature of the semantic constraints, and (2) the use of online grammaticality judgments (Chapter 4 and 5 of this thesis) and production priming (Chapter 3 of this thesis).

Semantic ratings were obtained for a total of 475 verbs – each of which was rated by 16 adults – on the assumption that a three-way distinction of thematic roles (agent-patient, theme-experiencer, and experiencer-theme verbs) was not sufficient to characterize the detailed semantic constraint. Each of these verbs was therefore rated for the following properties, presented in the form A VERBed B without mention of passives:

A causes (or is responsible for) some effect/change involving B
A enables or allows the change/event
A is doing something to
A is responsible

A makes physical contact with B
B changes state or circumstances
B is responsible
It would be possible for A to deliberately [VERB] B
The event affects B in some way
The action adversely (negatively) affects B

These ten ratings were then combined to create an "affectedness" score for each verb.

On a subsequent grammaticality judgment task with 20 adults, it was found first that *total* verb frequency (mainly a control predictor) has an effect on acceptability, but a greater effect for actives than passives, while *passive* verb frequency has a greater effect for passives than actives. Even after controlling for frequency, the key predictor of semantic affectedness also predicted the acceptability of both sentence types but, crucially, had a bigger effect for passives than actives. This provides evidence that, at least to some extent, the semantics of affectedness particularly characterises the passive construction.

In order to address any doubts regarding this finding, since a possible reason for this effect might be due to the inclusion of non-passivizable verbs (e.g., **£5 was cost by the book*), another grammaticality judgment was conducted with a further 16 adults, using 72 "core" verbs (rather than 475), all of which were passivizable. This study found similar results, and these core verbs form the basis of the set used in some of the studies in this thesis (Chapters 4 and 5)

Finally, in order to address the apparent disparity between the results of this study, which found a semantic effect for the passive, and the adult findings of Messenger et al's (2012) forced-choice comprehension study, which did not, a new forced-choice comprehension task was conducted with 16 adults, but using a reaction-time measurement. Through looking at the interaction of sentence type by semantic affectedness (the same adult ratings), it was found that affectedness has a greater effect of "speeding up" reaction times for passive than active sentences; i.e., reaction time to choose the matching picture decreases as semantic affectedness increases, for passives but not (or at least significantly less so) for actives. On the basis if these findings, the study made an important point to consider in future research: semantic effect can and

should be measured in a gradient fashion (c.f. Meints, 1999; Messenger et al, 2012) without the necessity of fully adopting either of the two theoretical standpoints (generativist/rule-based or constructivist). That is, knowledge can be both "fully abstract" (as it is in adults) but at the same time a semantic construction prototype.

Given the need to test this account cross-linguistically, Aryawibawa and Ambridge (2018) adopted the Ambridge et al. (2016) methodology and applied its two major studies (verb semantic rating task and grammaticality judgments for the core verbs) to the Indonesian language. This cross-linguistics test was possible due to the similarity of constructions (i.e., the use of word order to distinguish active-vs-passive and the lack of inflectional morphology on both the subject and the object). Grammatically though, differences between these languages are seen in that, in English, the unmarked structure is the active (with morphological marking verb required on the passive), while Indonesian has no "unmarked" form: both active and passive require morphological marking:

(40) Active: Ibu **men**endang ayah

Mother ACTIVE-kick father

(41) (Canonical) Passive: Ayah **di**tendang oleh ibu

Father PASSIVE-kick mother

The "bare" unmarked form of the verb is only seen in another passive construction that Indonesian uses and that can be considered non-canonical (i.e., a topicalization construction or "object voice"):

(42) Noncanonical passive: Ayah, ibu **ø**-tendang
Father, mother kicked

In the experiment, 76 adult participants (16 for semantic ratings and 60 for the grammaticality judgment tasks), it was revealed that the verb semantic-affectedness effect was larger for canonical than the non-canonical passives (i.e., a significant interaction); thus, providing strong evidence that support the account of semantic effects for the passive cross-linguistically. In particular, there were three arguments to

support the semantic account; (1) the semantic effect appear even in a construction where subject is the argument of the verb (reversible, unlike some of the 475 verbs in the larger set of Ambridge et al, 2016), (2) the semantic effect is not a "topicalization effect" in disguise (Indonesian uses a topicalization construction, for which no semantic effects were found), and (3) grammatical acceptability judgment scan be used to measure syntactic representation – if syntactic representation contain no semantic information (Branigan & Pickering, 2017), then acceptability judgments should not be affected by semantic factors; which they were in both this study and Ambridge et al (2016).

A similar cross-linguistic study was also conducted for Mandarin Chinese (Liu & Ambridge, 2021) with a similar method of using 16 native speakers for the semantic rating task and another 60 native speakers for the grammaticality judgment task. Although this study was additionally aimed at building a computational model of passive acquisition (and in particular the need to balance information structure and construction-semantic considerations), it also included a version of the experiment conducted for English and Indonesian. Just as is the case for Indonesian (Aryawibawa & Ambridge, 2018), the Mandarin passive has a similar form to the English passive (which enabled the use of a similar method), but has two different type of passives and two different types of actives. For passives, Mandarin has the canonical passive (BEI passive) and the notional passive (topicalization construction), while in actives, it has the canonical SVO active and a BA- active which, interestingly, has exactly the semantics of "affectedness" that we have been discussion for English and Indonesian passives. The results of the semantic-ratings and grammaticality-judgment experiments indicated that, as predicted, BEI passive and BA actives showed greater effects of semantic affectedness (i.e., a sentence type x semantics interaction) than the other passive and active constructions. Although frequency effects were also found, the authors argued that it is plausible to assume that frequency effects are a consequence of semantic effects: i.e., a speaker would use specific linguistic item in a specific construction more frequently if it has higher acceptability. This is important for the thesis study that replicates the English, Indonesian and Mandarin studies above with Balinese since, for Balinese, no corpus counts are available. That said, it is interesting to note, that despite the clear significant semantic effects found for the passive (in Liu & Ambridge, 2019), some individual verbs were more frequent, and

more acceptable, in the passive than their semantic rating would predict, providing argument that frequency (via conventionalization) can sometimes override semantics.

To sum up, both abstract syntactic and meaning-based semantic representations seem to characterize the adult representation of the passive. From a methodological standpoint, although the formalist/lexicalist versus functionalist/constructivist debate over adult passive representations is key to debates between these theories in general, most previous studies have focussed on (a) children (mainly framing a semantics-based passive construction as an early immature "stage", rather than part of the adult grammar) and (b) English. Therefore, the following chapters will present new experiments on (all studies) adults and (Study 2) Balinese.

Chapter 3: Passive priming

Rationale for Study 1 in Chapter 3

Chapter 2 has discussed in detail some of the specific accounts from both generativist and constructivist approaches to adult language representations. It has also laid out specifically the fact that the passive will play a significant role in this thesis, since it involves both morphological inflection and construction of noncanonical sentences; and as such is an ideal test-case for movement-based versus construction-based accounts. With regard to child acquisition, generally, generativist accounts focus on 'innateness' (e.g., Chomsky, 1993; Culicover & Jackendoff, 2005; Müller, 2020), while constructivist accounts focus on gradual input (e.g., Pinker, 1987, Goldberg, 1997; Croft, 2005). With regard to the adult endpoint, the claims of these theories can be tested by not just adult studies, but through child studies as well, since adult representation is the 'endstate' of child acquisition – as children's abstract representations grow with age (at least according to constructivist approaches). Study 1 also fills something of a gap in the literature in that most previous studies of the passive that bear of the debate between generativist and constructivist accounts were focused on children. Findings that reflect a significant effect of semantics (specifically, affectedness) favour the constructivist account, which assumes that constructions have their own meanings (in the case of the passive, affectedness). However, it is important to note that under constructivist approaches, adults' representations are generally more abstract than children's – which suggests relatively small semantic effects to be expected in adults.

One previous child study (Messenger, Branigan, McLean, & Sorace, 2012) in particular found no semantic effect when studying the passive, leading to the later claim that "syntactic representation contains no semantic information" (Branigan & Pickering, 2017: 8). The present Study 1 in chapter 3 is a replication of the key study from that paper (Study 2 in Messenger et al, 2012) that was considered underpowered (*N=24*), extending the same picture-based production-priming study to a larger sample of adult participants (*N=240*). As mentioned in Chapter 2, Messenger et al's (2012) findings indicated that there were no changes to the magnitude priming despite the use of different verbs, which implied that there were no construction-semantic effects in

the priming. Although some small parts of the methodology have been changed to allow the study to be transformed into an online experiment, the study uses the same picture stimuli and materials, and investigates the magnitude of the priming effect by using different verbs (*agent-patient*, *theme-experiencer*, and *experiencer-theme*).

Since the present study was conducted only with adults, the high level of abstract representations assumed by the generativist account is also shared by the constructivist account, and we would therefore expect to see a main effect of priming. The difference between the theories can be investigated by examining the relative size of this priming effect, through the use of different verbs in the passive. Generativist accounts would seem to predict a small-to-nonexistent semantic effect in adults, constructivist accounts would seem to predict a semantic effect, since verbs vary as to their semantic compatibility with the passive construction. Importantly, similar semantic effects are expected for other languages that have passive constructions; and this crosslinguistic factor is investigated using a different methodology in Study 2 (Chapter 4).

The present Study 1 has been published in *Collabra: Psychology* (Darmasetiyawan, Messenger, & Ambridge, 2022).

1.0 Introduction

There can hardly be a question that is more central to the cognitive sciences than that of how language – and in particular grammatical structure – is represented in the brain. To frame the question in more concrete terms, consider a sentence such as *A witch is being hugged by a cat* (a sentence that the vast majority of English speak-ers have never previously encountered). What are the syntactic representations that allow any English speaker to produce (and, indeed, comprehend) this sentence?

One class of approaches – which we term semantics-based approaches – holds that speakers produce and comprehend such utterances using constructions: pairings of forms and functions that they have acquired by abstracting across input utterances (e.g., Goldberg, 1995; 2006; Langacker, 2008). For example, the utterance *A witch is being hugged by a cat* might be formed using the construction (approximately speaking) [AGENT] [BE] [ACTION] by [PATIENT].

A rival class of approaches – which we term pure syntax approaches – holds that there exists a "syntactic level of representation [that] includes syntactic category information but not semantic information…or lexical content" (Branigan & Pickering, 2017: 8). This system "operates in a particular way, manipulating categories via their form, and not their meaning" (Adger, 2017: 29). For example, the utterance *A witch is being hugged by a cat* might be formed using the syntactic representation (again, very approximately speaking) [S [NP] [VP [AUX] [V] [PP [P] [NP]]]] (from Branigan & Pickering, 2017: 8). This class of approaches includes not only approaches firmly in the Chomskyan tradition (e.g., Chomsky, 1993; Newmeyer, 2003; Adger, 2017) but also "simpler syntax" approaches (e.g., Pollard & Sag, 1994; Culicover & Jackendoff, 2005; Branigan & Pickering, 2017: 8), which posit "a single level of syntax that includes constituent structure" but "no separate levels containing…reordered constituents (e.g., Deep Structure) or unordered constituents (e.g., incorporating hierarchical structure but not linear order)" (Branigan & Pickering, 2017: 8).

Of course, pure syntax approaches do not assume that semantic information is not represented in the grammar at all. On the contrary, they assume that syntax and semantics are intimately linked, and different individual accounts make different assumptions regarding the nature of these links. For example, one possible interpretation of accounts such as Pickering and Branigan (1998) is that encountering a particular verb may activate not only the relevant lexical node, but also lexical nodes for verbs with similar meanings. Similarly, Cai, Pickering and Branigan (2012) advocate – and present evidence for – an account under which thematic role-syntax mappings (e.g., THEME=SUBJECT) are stored, and yield priming effects.

At least one such account, however, is – at least on our reading – unambiguous in its claim that "syntactic representations do not contain semantic information" (Branigan & Pickering, 2017: 8). In particular, Branigan and Pickering (2017: 2) claim that the results of syntactic priming studies – including Messenger, Branigan, McLean & Sorace (2012) – are "consistent with priming of representations that are specified for syntactic information but not semantic, lexical, or phonological information".

1.1 Evidence for *pure-syntax* representation of the passive

A key testing ground for this debate has long been studies of the passive (mainly, but not exclusively, the English passive). In addition to the study of Bock and Loebell (1990; but see Ziegler, Bencini, Goldberg & Snedeker, 2019), Branigan and Pickering (2017:16) cite as a key piece of evidence for their approach the syntactic priming study of Messenger et al (2012), in which both adults and children "were primed to produce passives involving Patient/Agent thematic roles (e.g., *The witch was hugged by the cat*) **to the same extent** when the prime involved *Experiencer/Theme* roles (e.g., *The girl was shocked by the tiger*) and *Theme/Experiencer* roles (e.g., *The girl was ignored by the tiger*)". [Emphasis added].

This finding is particularly key to Branigan and Pickering's (2017) argument, since it undermines a large number of previous studies that showed apparent effects of semantics on passive production and comprehension. Pinker, Lebeaux and Frost (1987) characterized the semantics of the passive construction in terms of "affected-ness" such that

> [B] (mapped onto the surface subject [of a passive]) is in a state or circumstance characterized by [A] (mapped onto the *by*-object or an understood argument) having acted upon it.

Accordingly, several previous comprehension studies (Fox & Grodzinsky, 1998; Gordon & Chafetz, 1990; Hirsch & Wexler, 2006; Maratsos, Fox, Becker, & Chalkley, 1985; Meints, 1999; Sudhalter & Braine, 1985) had found that children showed better performance for passives with *agent-patient* verbs (e.g., *The girl was bitten by the tiger*) than passives with *experiencer-theme* verbs (e.g., *The girl was ignored by the tiger*) (see also Ferreira, 1994 for adults). These results have been interpreted by some as reflecting limitations in young children's representations of passive syntax (e.g., Borer & Wexler, 1987; Fox & Grodzinsky, 1998, cf. Messenger et al 2012). However, since adults' spontaneous passives more often contain *theme-experiencer* verbs (e.g., *The girl was shocked by the tiger*; Maratsos et al 1985) and since the subject of passive with (for example) *bitten* or *shocked* is – almost by definition – more affected than the subject of a passive with (for example) *ignore*, these findings have alternatively been

taken as evidence that children's representation of the passive (and possibly adults' too) is semantically constrained in something like the way proposed by Pinker et al (1987). That is, these findings have been taken as evidence for *semantics-based* approaches (Maratsos et al 1985). Messenger et al's (2012) finding that *theme-experiencer* and *experiencer-theme* verbs appear to be **equally effective** at priming passives (e.g., *The witch was hugged by the cat*) challenged both conclusions by showing that (a) both adults and children have a syntactic representation for the passive and (b) this representation is seemingly impervious to semantic information. That is, these priming effects constitute evidence for *pure-syntax* approaches. They are difficult to reconcile with semantics-based approaches, which would seem to predict a greater priming effect for *theme-experiencer* (e.g., *frighten*) than *experiencer-theme* (e.g., *ignore*) passives; at least on the assumption that semantically more prototypical passives (i.e., *theme-experiencer* passives) lead to greater activation of speakers' passive representation than do semantically less prototypical passives (i.e., *experiencer-theme* passives).

1.2. Do syntactic representations of the passive contain semantics after all?

Following the publication of Messenger et al (2012), Ambridge and colleagues published a series of studies demonstrating apparent semantic effects on the passive, for both adults and children.

First, focussing on adults, Ambridge, Bidgood, Pine, Rowland and Freudenthal (2016) showed that independent ratings of verbs' "affectedness" (designed to capture Pinker's semantic constraint on the passive construction) predicted both the rated grammatical acceptability of passives and (negatively) reaction-time in a forced-choice comprehension task. Importantly, while similar effects were observed for actives too, a significant interaction demonstrated that the effect was bigger for passives. This latter finding contradicts another finding reported by Messenger et al (2012) that, for both adults and children, forced choice comprehension was worse for *experiencer-theme* than *theme-experiencer* verbs, but to an equal extent across passives and actives, perhaps because the former are more difficult to illustrate (c.f., *The girl was ignored/frightened by the tiger*). The grammatical acceptability findings of Ambridge et al (2016) were subsequently replicated in Indonesian (Aryawibawa &

Ambridge, 2018), Mandarin Chinese (Liu & Ambridge, 2021), Balinese (Darmasetiyawan & Ambridge, submitted) and Hebrew (Ambridge, Arnon & Bekman, in preparation).

Second, adopting Messenger et al's (2012) distinction between *theme-experiencer*, *experiencer-theme* and *agent-patient* verbs (e.g., *frighten*, *ignore*, *hit*) Bidgood, Pine, Rowland and Ambridge (2020) again found that *experiencer-theme* verbs showed the worst performance in a forced-choice comprehension task; in this case for both children and adults. Again, although a similar effect was observed for actives, a significant interaction demonstrated that (contra the findings of a similar study in Messenger et al, 2012) the effect was bigger for passives.

Third, Bidgood et al (2020) went on to show that, in a passive priming study, both adults and children produced fewer *experiencer-theme* passives (e.g., *The girl was ignored by the tiger*) than *theme-experiencer* passives (e.g., *The girl was shocked by the tiger*; and also than *agent-patient* passives; e.g., *The girl was hit by the tiger*). This finding was later replicated (using a slightly different methodology) for children with and without autism spectrum condition (Ambridge, Bidgood & Thomas, 2021). Note that these later priming studies reversed the design used by Messenger et al (2012): Messenger et al held constant the type of the target verb as *agent-patient* (e.g., *hit*) and investigated the effect of manipulating the prime verb: *theme-experiencer* (e.g., *frighten*) vs *experiencer-theme* (e.g., *ignore*). Ambridge and colleagues held constant the type of the prime verb as *agent-patient* (e.g., *hit*) and investigated the effect of manipulating the target verb: *theme-experiencer* (e.g., *frighten*) vs *experiencer-theme* (e.g., *ignore*).

1.3. The present study

To sum up, the current literature yields contradictory evidence regarding the representation of the passive construction. Consistent with *semantics-based* accounts, several studies using grammaticality-judgment, comprehension and production-priming methods have shown an advantage for *theme-experiencer passives* (e.g., *The girl was shocked by the tiger*) over *experiencer-theme* passives (e.g., *The girl was ignored by the tiger*). Inconsistent with such accounts, and consistent instead with pure-syntax accounts, Messenger et al (2012) found that *theme-experiencer* and

experiencer-theme verbs appear to be equally effective at priming *agent-patient* passives (e.g., *The witch was hugged by the cat*). *Semantics-based* accounts predict that *theme-experiencer* passives (e.g., *frighten*) will yield a greater priming effect than *experiencer-theme* passives (e.g., *ignore*), since the former are more consistent with the semantics of the construction.

A key to resolving this contradiction may lie with the fact that, at least numerically speaking, the adult findings of Messenger et al (2012) are in the direction predicted by *semantics-based* accounts: Participants' increased production of passives following passive versus active primes is indeed greater for *theme-experiencer* primes (26% vs 9%; i.e., 17 percentage points) than for *experiencer-theme* primes (17% vs 9%; i.e., 8 percentage points). This raises the possibility that the findings of Messenger et al (2012) are indeed consistent with the predictions of *semantics-based* accounts, but that the study was not sufficiently powered to detect the effect.

The aim of the present study was therefore to conduct a pre-registered replication of the adult condition of Study 2 from Messenger et al (2012) using an online methodology, and a sample size appropriately powered to detect the crucial interaction of prime-type by verb-type, such that participants' increased production of passives following passive versus active primes is bigger for *theme-experiencer* (e.g., *frighten*) than *experiencer-theme* verbs (e.g., *ignore*).

2.0 Method

2.1 Participants

A sample size of N=240 was chosen on the basis of a power analysis based on Messenger et al's Study 2 adult data (kindly supplied by Kate Messenger). Details of the analysis can be found at https://osf.io/7fekv/ (R syntax). In brief, we first used the lme4 package (Bates et al, 2015) to build a mixed-effects model of the original data:

```
M2=glmer(RecodeStrict ~ PrimeType*VerbType + (1+PrimeType*VerbType|
Participant) + (1+PrimeType|Prime_Verb), adults,
family=binomial,glmerControl(optimizer ="bobyqa"))
```

The dependent variable was (binomial) participant response ("RecodeStrict": Active = 1, Passive = 0), with independent variables of PrimeType (Active/Passive) and VerbType (Theme-Experiencer/Experiencer-Theme), and the interaction term. Treatment coding (the default in R) was used. Following the recommendation of Barr, Levy, Scheepers and Tily (2013) we used all random intercepts and slopes that were justified given the design; a model which converged in lme4, provided that the bobyqa optimizer was used.

We then used the "extend" function of simr package (Green & MacLeod, 2016) to extend this model to 250 simulated participants, while retaining the model parameters. (Interestingly, with these 250 simulated participants, the crucial interaction is statistically significant, but only narrowly so, at p=0.028). Next, we used the "powerSim" function of this package to run 20 simulations of this model at each of ten sample sizes: 24, 48, 72…240 (for output, see https://osf.io/m8wx2/). These simulations found that a sample size of N=240 is required to yield at least 95% power for detecting a significant effect of the crucial interaction (PrimeTypeP:VerbTypeTE): Point estimate = 100%, 95 Confidence Interval = (83.16% – 100%). The 240 adult (18+) participants were recruited from a student experiment participation pool at the University of Liverpool, and from https://www.prolific.co. As in Messenger et al (2012), all were monolingual native speakers of British English. In accordance with our pre-registration (https://osf.io/a4tm5/) participants who completed the study but did not produce any passives were discarded and replaced (N=50). However, for consistency with Messenger et al (2012), who did not replace such participants (N=5/24), we also ran additional non-preregistered analyses in which they were retained. The study was approved by the University of Liverpool research ethics committee, and participants gave informed consent via the Gorilla platform (see https://gorilla.sc/openmaterials/44690; look for "Information and Consent" and click "Preview").

2.2 Analysis code

The remainder of the R syntax available at https://osf.io/7fekv/ constitutes our pre-registered data analysis code (written and tested on the basis of the simulated data described above). Briefly, we obtained priors for the Intercept, the main effects of Verb

Type and Prime Type and the Verb Type x Prime Type interaction from a new model of Messenger et al's (2012) *N*=24 adult data (model M2 above). We then, for 240 simulated participants, used the Savage-Dickey method to calculate a one-sided Bayes Factor for the crucial interaction (based on the methods outlined in Bannard, Rosner, & Matthews, 2017, and at https://rpubs.com/lindeloev/bayes_factors). These steps required the use of the packages brms (Bürkner, 2017), for running the Bayesian model, and logspline (Stone et al, 1997), for calculating the Bayes Factor. The use of a Bayesian approach is important here, as it allows us to quantify the strength of evidence for and – crucially – against the interaction of theoretical interest, and thus avoids the problem of inferring a null effect from a non-significant result. The use of pre-registered analysis code is an important strength of the present replication, because it removes all researcher degrees of freedom with regard to the statistical analyses. The pre-registration document (https://osf.io/a4tm5/) also specifies the reference levels according to which we interpret our Bayes Factor (those in Jarosz & Wiley, 2014).

Note that the Bayesian model used for our main analysis – like the frequentist model on which it was based (model M2 above) – used maximal random effects structure (following Barr et al, 2013). However, because Barr et al's (2013) recommendation has attracted some controversy in the literature, we additionally ran a set of exploratory (i.e., non-preregistered) analyses with different random-effects structures.

2.3 Design and Materials

The study was run online using the Gorilla platform. Readers can complete the study procedure at the following link https://gorilla.sc/openmaterials/44690 (look for "Syntax Priming" and click "Preview").

Our goal was to replicate Messenger et al's (2012) Study 2 as precisely as possible, with the only major difference being the online nature of the study. That is, we used the same 2x2 (Active/Passive Prime Sentence x Theme-Experiencer/Experiencer-Theme) design, the same number of trials per participant (24, plus 8 "snap" filler trials), and the same prime-target verb pairings, constructed according to the same four counterbalance lists. We used the same six *experiencer-theme* prime verbs (*ignore, remember, see, love, hear, like*), the same six *theme-*

experiencer prime verbs (*frighten, surprise, scare, shock, annoy, upset*), and the same eight *agent-patient* target verbs (*shake, wash, push, hug, kick, chase, kiss, drop*). The prime and target sentences, as well as the pictures that accompanied/elicited them (kindly supplied by Kate Messenger), were also identical to those used in Messenger et al (2012), and the audio recordings used to present the prime sentences were voiced by the same experimenter (Kate Messenger). A complete set of stimuli (for one of the four counterbalance lists) is shown in Table 2 below (though note that, within each list, trials were presented in fully random order, as determined by the Gorilla platform).

Table 2. Complete set of stimuli for one of the four counterbalance lists

Participants hear an audio recording of the Prime Sentence (accompanied by a matching picture) and are then presented with the accompanying Target Picture, which they then describe verbally (with their audio recorded), usually producing either an active (e.g., *A tiger is shaking a doctor*) or a passive (e.g., *A doctor is being shaken by a tiger*)

Verb Type	Prime Type	Prime Sentence	Target Picture
ET	Passive	a girl is being ignored by a bear	tiger shaking doctor
ET	Passive	a doctor is being remembered by a rabbit	elephant washing robber
ET	Passive	a fairy is being seen by a horse	lion scratching nurse
ET	Passive	a fireman is being loved by a lion	cow licking king
ET	Passive	a queen is being heard by a cow	pig pushing witch
ET	Passive	a boy is being liked by a pig	bear pinching soldier
TE	Active	a cat is frightening a witch	rabbit hugging girl
TE	Active	a dog is surprising a robber	frog tickling fairy
TE	Active	a tiger is scaring a soldier	horse kicking clown
TE	Active	a frog is shocking a king	cat chasing boy
TE	Active	an elephant is annoying a clown	sheep kissing queen
TE	Active	a sheep is upsetting a nurse	dog punching fireman
TE	Passive	a king is being frightened by a dog	elephant shaking witch
TE	Passive	a fireman is being surprised by a horse	bear washing clown
TE	Passive	a witch is being scared by a bear	tiger scratching king
TE	Passive	a clown is being shocked by a cat	pig licking fairy

TE	Passive	a boy is being annoyed by a frog	dog pushing girl
TE	Passive	a queen is being upset by an elephant	cat pinching nurse
ET	Active	a rabbit is ignoring a soldier	sheep hugging boy
ET	Active	a tiger is remembering a nurse	rabbit tickling queen
ET	Active	a lion is seeing a doctor	cow kicking fireman
ET	Active	a sheep is loving a girl	horse chasing soldier
ET	Active	a pig is hearing a robber	frog kissing doctor
ET	Active	a cow is liking a fairy	lion punching robber
NA	Snap	a bear is picking-up a king	bear picking-up king
NA	Snap	a rabbit is feeding a witch	rabbit feeding witch
NA	Snap	a cat is poking a queen	cat poking queen
NA	Snap	a dog is dropping a fairy	dog dropping fairy
NA	Snap	a girl is being picked-up by an elephant	elephant picking-up girl
NA	Snap	a boy is being fed by a lion	lion feeding boy
NA	Snap	a clown is being poked by a frog	frog poking clown
NA	Snap	a robber is being dropped by a tiger	tiger dropping robber

2.4 Procedure

In order to replicate as closely as possible the procedure of Messenger et al (2012) – which was optimized for use with both adults and children – we adopted the same "Snap" game framing. First, participants read the following onscreen instructions:

> In this experiment, you will take turns with a (virtual) experimenter to describe pictures.
>
> The experimenter will describe her picture, then you should – out loud – describe yours.
>
> BUT there is one more thing to remember: Sometimes, the experimenter's picture and your picture will be identical. When this happens, DON'T describe your picture – instead say "SNAP!" as quickly as possible.

The instructions then introduced the procedure for testing the online audio recording procedure, and a set of X practice trials:

Let’s have a practice…

We will record your voice. But first, before we start, let's just check the sound is working. When prompted, you will need to give Gorilla permission to access your microphone. Have fun!

Participants then completed the four practice trials shown in Table 3 (again, identical to those used in Messenger et al, 2012). All used agent-patient verbs and consisted of two active primes, two passive primes and one “snap” filler trial. For each practice trial, unlike the main study, the prime and target sentences used the same agent, patient or both.

Table 3. Practice trials

Verb Type	Prime Type	Prime Sentence	Target Picture
AP	Active	a penguin is tripping a pirate	mouse tripping pirate
AP	Active	a donkey is waking a builder	donkey waking policeman
AP	Passive	a gnome is being followed by a monkey	monkey catching gnome
AP	Snap	a ballerina is being stung by a bee	cow licking king

No feedback was given during the practice trials (again, mirroring the original study, in which only general encouragement was given), although participants were presented with a reminder of the task:

That’s the end of the practice trials.

Did you remember to either describe your picture as soon as it appears or – if it’s the same as the experimenter’s – say SNAP?

Now click Next to start the study proper.

Participants then completed the 32 experimental trials in random order (see Figure 6 for an example of a standard trial and a "snap" filler trial respectively). At the start of each trial, the experimenter's picture was already present on the left-hand side of the page, and playback of the prime sentence began immediately. 1.5 seconds after the offset of the prime sentence, the participant's picture then appeared. After speaking her sentence, the participant clicked "Stop Recording" to move immediately on to the next trial.

The following instructions remained onscreen at all times:

The first recording you hear describes the picture on the left screen
Describe your picture immediately after you see the second picture on the right screen
Press Stop Recording when you are ready to continue.

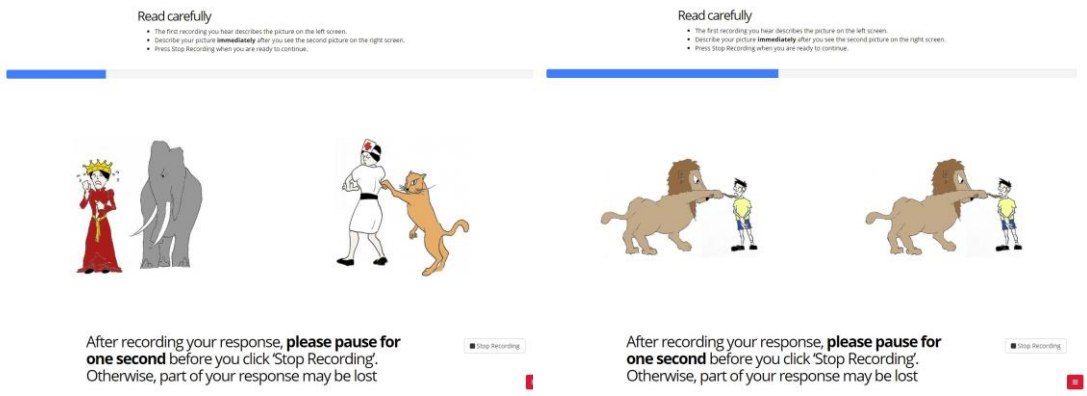

Figure 6. Example trial for (a) standard trial (b) "snap" filler trial

2.5 Transcription and coding

Audio responses were transcribed by the first author, and all were subsequently coded by both the first and second authors independently. Initial agreement was 95.1% (Kappa=0.87) and 96.1% (Kappa=0.89) according to the strict and lenient coding schemes set out in Messenger et al (2012) respectively (defined below). In all but three cases, apparent disagreements reflected simple misunderstandings of the coding scheme, and were easily rectified. For the remaining three sentences, agreement was reached by discussion.

As per Messenger et al (2012) and our preregistration document – we "base our interpretation on the analysis resulting from the strict scoring criteria". These criteria (from Messenger et al, 2012: 574) are reproduced below:

> A target description was scored as an Active if it was a complete sentence that provided an appropriate description of the transitive event in the target picture and contained a subject bearing the agent role, a verb, and a direct object bearing the patient role, and could also be expressed in the alternative form (i.e., a passive). A target description was scored as a Passive if it was a complete sentence that appropriately described the picture's event and contained a subject bearing the patient role, an auxiliary verb (get or be), a main verb, a preposition by and an object bearing the patient role, and that could also be expressed in the alternative form (i.e., an active)…. We also re-coded the data using more lenient scoring criteria …whereby short passive and short active descriptions were coded as Passive and Active descriptions respectively.

Note that these criteria do not necessarily require that the participant use the verb and/or noun phrase intended, provided that it constitutes "an appropriate description". For example, if instead of the intended A doctor is being shaken by a tiger a participant produced A surgeon is being attacked by a leopard, the sentence would still be scored as an appropriate passive. Such substitutions are allowed, since the experimental manipulation concerns the prime verb, not the target verb (and does not directly relate per se to the verbs' arguments). As in Messenger et al (2012), only trials scored as complete appropriate Active or Passive responses were retained in the statistical analysis, with all others treated as missing data.

3.0 Results

3.1 Confirmatory preregistered analysis

Figure 7 (produced using the yarrr package, Phillips, 2018) shows the mean number of passives versus actives produced following active and passive primes with *experiencer-theme* (e.g., *see*) and *theme-experiencer* verbs (e.g., *frighten*), along with 95% Bayesian Highest Density Intervals ([HDIs]). The pattern of these means is consistent with the prediction that participants' increased production of passives following passive versus active primes is bigger following primes with *theme-experiencer* verbs (**0.45** [0.42,0.47] **vs 0.10** [0.09, 0.12]) than primes with *experiencer-theme* verbs (**0.34** [0.32, 0.37] **vs 0.10** [0.08, 0.11]).

As per our pre-registered syntax, we fitted the following maximal Bayesian model to the data:

RecodeStrict ~ PrimeType * VerbType + (1 + PrimeType * VerbType | Par-ticipant) + (1 + PrimeType | Prime_Verb)

Replicating Messenger et al (2012), we found a large effect of Prime Type (*M*=-2.23 [-3.00, -1.42]) such that more passives were produced following passive than active primes (*M*=0.39, [0.38, 0.41] vs *M*=0.10 [0.09, 0.11]), but no evidence of an effect of Verb Type (*M*=-0.05 [0.12, -0.27]). Note that because these effects are not of primary theoretical interest, we did not include investigation of them in our pre-registered syntax; these claims are based solely on whether or not the credible interval includes zero. It is also important to bear in mind that since we used treatment (/dummy/baseline) coding rather than effect (/sum/deviation) coding, the effects of Prime Type and Verb Type are *simple effects* rather than ANOVA-style *main effects* (e.g., https://mediaup.uni-potsdam.de/Play/Chapter/223). That is, the effect of Prime Type – more passives following passives than active primes – is the effect of prime type when verb type is *Experiencer-Theme* (the baseline). In hindsight, it would probably have been better to use effect coding, in order to yield an estimate of Prime Type as a main effect. However, this is not a serious problem given that (a) a main effect of Prime Type is clearly visible in Figure 7 and (b) the effect of primary theoretical interest is the *interaction* of Prime Type by Verb Type, whose interpretation is identical under treatment and effect coding.

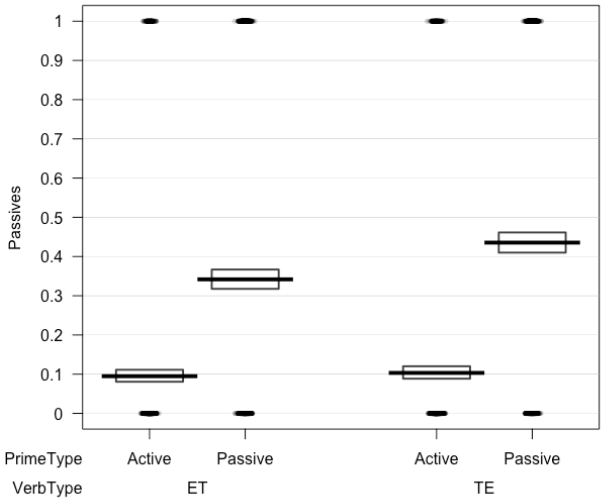

Figure 7. Proportion of passives produced following Active and Passive Prime sentences with experiencer-theme (ET) verbs (e.g., *ignore*) and theme-experiencer (TE) verbs (e.g., *shock*)

To test the crucial prediction of an interaction of Verb Type by Prime Type (recall from Figure 7 that the observed means were in the predicted direction), we calculated one-sided Bayes Factors using the Savage-Dickey method (see Appendix A for model summary and calculations). The Bayes Factor was 2.11 which, according to our pre-registered reference standard (Jarosz & Wiley, 2014) constitutes "Weak" (Raftery) or "Anecdotal" (Jeffreys) evidence for H1 over H0. That is, the observed data are roughly twice as likely under a scenario in which participants' increased production of passives following passive versus active primes is bigger for *theme-experiencer* than *experiencer-theme* prime verbs than under a scenario in which participants' increased production of passives following passive versus active primes is unrelated to prime verb type.

3.2 Are these findings robust to coding and exclusion decisions (exploratory analyses)?

The findings above (like the main findings in Messenger et al, 2012) are based on the strict coding scheme. Recall, however, that we also coded responses under a more lenient coding scheme which allows short passive and active forms. Furthermore, and in contrast to Messenger et al (2012), the findings above are based on data from 240 participants, all of whom produced at least one passive, excluding data from 50 participants who did not. In order to check whether the findings reported above are robust to these (preregistered) decisions, we ran additional exploratory Bayesian analyses using the lenient coding scheme, *N*=240 (Appendix B), the strict coding scheme, N=290 (Appendix C), and the lenient coding scheme, *N*=290 (Appendix D). Note that the (in principle) *N*=290 analyses in fact include only 280 participants, since 10 failed to produce at least one scorable active or passive under either the strict or lenient coding scheme, and so were automatically excluded.

The findings of these additional analyses were all but identical to those of the main analysis. This is to be expected given that (a) the vast majority of responses were full actives or passives, meaning that the inclusion of short forms under the lenient coding scheme makes little difference and (b) the additional inclusion of participants who produced no passives inevitably dilutes the overall priming effect to a small degree, but – since they produced no passives – makes little difference to the *relative* rates of passives following *experiencer-theme* vs *theme-experiencer* passive primes. For the record, the Bayes Factor for the crucial interaction of Verb Type by Prime Type was 2.11, 2.00, 2.11 and 2.13 for the analyses in Appendix A-D respectively.

3.3 Are these findings robust to different random effects structures, and to the use of a frequentist analysis strategy (exploratory analyses)?

All of the findings reported so far (both confirmatory and exploratory) are based on models with maximal random effects structure (Barr et al, 2013). However, a number of recent studies (Bates, Kliegl, Vasishth & Baayen, 2015; Matuschek, Kliegl, Vasishth, Baayen & Bates, 2017; Bates, 2019) have argued that maximal models are *too* conservative – which decreases power – and instead advocate model selection by some goodness-of-fit criterion (e.g., AIC, BIC, likelihood ratio test). Other studies have cautioned against removing terms from the random effects structure simply because they cause convergence failure (Eager & Roy, 2017) or fail some

goodness-of-fit criterion (Heisig & Schaeffer 2019). Given the lack of agreement amongst experts, we therefore decided to adopt a mixed-effects-multiverse approach (Ambridge, 2021), and test for the crucial interaction of Verb Type by Prime Type (as well as the observed simple priming effect of Prime Type) under models with all possible random effects structures. Given the very large number of models this entails, and the fact that each takes several hours to run under a Bayesian approach, we adopted a frequentist approach, using the lme4 package (Bates et al, 2015). This also allows us to check whether the conclusions drawn on the basis of the main analysis – which used a Bayesian maximal models approach – hold under a frequentist approach. Using the bobyqa optimizer, 74/83 possible lme4 models achieved convergence (including all of those with the closest to maximal random effects structure).

The model (see Appendix E) plots, for these 74 models, (a) the mean estimate and standard error and (b) p values (approximated via the z-distribution) for the crucial interaction of Verb Type by Prime Type, as well as the simple priming effect of Prime Type. The simple priming effect is comfortably significant (adopting the conventional cutoff of $p<0.05$) under all random effects structures. For the crucial inter-action, the picture is more complicated. Rather alarmingly, an unscrupulous re-searcher could achieve almost any p value required from well under 0.05 to almost 1.0 by choosing a particular random effects structure. Reassuringly, though, the models with low AIC values, indicating good model fit, give much more uniform, nonsignificant estimates. Fortunately, the maximal model structure adopted for the main Bayesian analysis (AIC=4212; 1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime Verb; shown 22nd from the left) was a fairly typical one; although – at least on the basis of AIC – it was somewhat overparameterized: The most parsimonious model (AIC=4206) includes by-participant random-slopes for Prime Type and Verb Type (but not the interaction) and a by-prime-verb random slopes for Prime Type, but no random intercepts at all. Importantly, all of the models with low AIC values yielded estimates of the interaction close to that obtained from the main Bayesian analysis (M= -0.47, SE=0.45), whose conclusions can therefore be taken as robust.

3.4. Are these findings robust to the use of a continuous measure of verb semantics (exploratory analyses)?

All of the findings reported so far (both confirmatory and exploratory) are based on statistical models that treat verb semantics as a categorical predictor (*experiencer-theme / theme-experiencer*). However, several other studies of this construction (Ambridge et al, 2016; Aryawibawa & Ambridge, 2018; Liu & Ambridge, 2021; Darmasetiyawan & Ambridge, submitted; Ambridge, Arnon & Bekman, in preparation) have instead used a continuous measure of passive-relevant verb semantics: "affectedness" ratings obtained from adult speakers. In order to investigate whether the findings above are robust to the use of a continuous measure of verb semantics, we reran the main analysis above replacing the dichotomous predictor of Verb Type with scaled and centred continuous affectedness ratings taken from Ambridge et al (2016). Because we have no basis for setting priors for this analysis, we used a wide, flat prior (*M*=0, SD=10) and did not calculate Bayes Factors.

The findings of this analysis are shown in Appendix F. Although the magnitude of the simple effect of Prime Type was virtually unchanged (*M*= -2.62 [-3.33, -1.92]), the crucial interaction of Prime Type by Verb Semantic Rating (c.f., Verb Type) was reduced (*M*= -0.15 [-0.82, 0.53]). Thus, as shown in Appendix F, although the proportion of passives (blue line) versus actives (red line) is – as predicted – greater following verbs in which the passive subject is highly affected (SUBJECT is being *annoyed/scared/shocked/surprised*…vs *heard/seen/liked/remembered*…) the 95% confidence interval straddles zero, indicating no strong evidence for an effect. This confirms the finding from the main analysis that the effect of verb semantics, while probably not quite zero, is negligible.

3.5. Do these data show any evidence of prime-surprisal effects (exploratory analyses)?

Several syntactic priming studies (e.g., Bernolet & Hartsuiker, 2010; Jaeger & Snider, 2013; Peter et al., 2015) have observed *prime surprisal* or *inverse frequency* effects, such that the priming effect is increased when the verb+Prime Type combination that serves as the prime sentence is of low frequency (i.e., "surprising").

For example, the verb *tell* is considerably more frequent in the DO dative (*The writer told the publisher a story*) than the PO dative (*The writer told a story to the publisher*). Conversely, the verb pass is considerably more frequency in the PO dative (*The writer passed a story to the publisher*) than DO dative (*The writer passed the publisher a story*). Thus, holding construction constant (here, as DO dative), *The writer passed the publisher a story* is considerably more surprising than *The writer told the publisher a story*, and thus leads to greater priming; i.e., greater production of DO versus PO datives.

In order to investigate whether the present data show any evidence of prime-surprisal effects, we repeated the analysis from the previous section, replacing the by-verb continuous semantics measure with – for separate analyses – two different by-verb surprisal measures. Both of these measures were calculated from the by-verb active and passive corpus counts reported in Ambridge et al (2016).

- ***Proportion of passives versus actives***. Jaeger and Snider's (2013) corpus measure of surprisal was based on the conditional probability of the prime structure (in our case, passive) given the verb. However, because – for the present dataset – active and passive uses sum to 100%, conditional probability is equivalent to the simple proportion of passive versus active uses of each verb. We therefore used this simpler measure (scaled and centred).
- ***Chi-square measure***. A disadvantage of the proportion measure above is that it is insensitive to the raw frequency of passive versus active uses of each verb. We therefore calculated for each verb a chi-square statistic which reflects the extent to which, compared to other verbs in the corpus (N=475), it is biased towards (multiply by 1) or against (multiply by -1) passives. Again, this measure was scaled and centered.

The findings of this analysis are shown in Appendix G (proportional measure) and Appendix H (chi-square measure). In both plots, the regression lines for active and passive sentences are almost flat and almost parallel, suggesting no evidence of a prime-surprisal effect (i.e., no evidence of an interaction of Prime Type by either the Proportional or Chi-Square surprisal measure); a pattern confirmed by the statistical models. Indeed, if anything, the plots suggest a reverse-prime-surprisal effect: a larger

passive priming effect for verbs that are more frequent in the passive (e.g., *annoy, scare, shock, surprise* vs *hear, see, like, remember*). This pattern is consistent with the – albeit tiny – effects observed in the main and continuous-semantics analyses above. Compared to *experiencer-theme verbs* (e.g., *hear, see, like, remember*), *theme-experiencer* verbs (e.g., *annoy, scare, shock, sur-prise*) (1) score higher for continuously-rated semantic affectedness (2) are more frequent in the passive and (3) yield (marginally) higher rates of passive priming (NOT lower rates as would be predicted under prime-surprisal).

One possible reason why a prime surprisal effect was not observed in these data is that, regardless of the identity of verb, the passive construction is *extremely* surprising in and of itself, constituting – in the corpus counts used for the present analyses – around 1% of all verb uses. Consequently, all verb+passive combinations were hugely – and roughly equally – surprising: Even the least surprising (i.e., most passive-biased) verb, *ignore*, is 98.6% surprising in the passive (i.e., 1.4% passive uses), meaning that all other verbs can be more surprising to the tune of less than 1½ per-centage points. No wonder, then, that we failed to find any evidence that one verb is more surprising in the passive than another.

On the other hand, it is important to remember that any prime surprisal effect for the present dataset would run counter to the effect of verb semantics already observed (albeit very weakly). Perhaps the frequency with which a verb appears in a particular construction (here the passive) is somehow differently related to surprisal and/or priming effects than the semantic compatibility between the verb and the construction. That said, given that neither a semantic nor a prime surprisal effect was strongly evidenced in the present study, this issue must await further research.

3.6 Summary

To return to the main, preregistered analysis, while these data constitute only weak support for the experimental hypothesis, they can certainly not be taken as support for the original claim of Messenger et al (2012: 568): that "the magnitude of priming was unaffected by verb type". That is, they do not offer any support for this null hypothesis, which – on the basis of the present data – is only around half as likely as the alternative hypothesis (*BF*=2). Then again, the finding of such weak, anecdotal evidence from

such a large sample suggests that the magnitude of priming is affected, if at all, to only a very small degree.

4.0 Discussion

The aim of the present study was to conduct a particularly stringent pre-registered investigation of the claim that there exists a level of linguistic representation that "includes syntactic category information but not semantic information" (Branigan & Pickering, 2017: 8). As a test case, we focussed on the English passive; a construction for which previous findings have been somewhat contradictory. On the one hand, several studies using different methodologies have found an advantage for *theme-experiencer* passives (e.g., *The girl was shocked by the tiger*; and also *agent-patient* passives; e.g., *The girl was hit by the tiger*) over *experiencer-theme* passives (e.g., *The girl was ignored by the tiger*). On the other hand, Messenger et al (2012) found no evidence that *theme-experiencer* and *experiencer-theme* passives vary in their propensity to prime production of *agent-patient* passives.

The aim of the present study was therefore to conduct a pre-registered replication the adult condition of Study 2 from Messenger et al (2012) using an online method-ology, and a sample size (N=240) appropriately powered to detect the crucial inter-action of prime-type by verb-type, such that participants' increased production of passives following passive versus active primes is bigger for *theme-experiencer* (e.g., *frighten*) than *experiencer-theme* verbs (e.g., *ignore*).

In fact, our preregistered Bayesian analysis found only "Weak" (Raftery) or "Anecdotal" (Jeffreys) evidence for the presence of this interaction, with a Bayes Factor of around 2 indicating that the observed data are roughly twice as likely under the presence of this interaction than its absence. This conclusion of, at most, a small, anecdotal effect of verb semantics was robust to (a) different coding and exclusion decisions, (b) different random effects structures and a frequentist approach and (c) the use of a continuous – as opposed to dichotomous – measure of verb semantics. Neither did we find any evidence for (d) a prime-surprisal effect whose predictions are – although differently operationalized – more-or-less in the opposite direction to those of the verb semantics hypothesis.

On the other hand, these findings do not constitute support for the claim of Messenger et al (2012: 568): that "the magnitude of priming was unaffected by verb type", since this null hypothesis received only half as much support as the alternative hypothesis.

It is important to bear in mind, however, that in contrast to the interaction, the main effect of prime type, which is generally considered to constitute evidence of syntactic priming, was very large: Participants produced passives at a rate of 39% following passive primes (Bayesian 95% Highest Density Interval = 38%-41%) but only 10% (HDI = 9%-11%) following active primes. Thus, in contrast to very weak evidence for an influence of semantics, we seemingly have very strong evidence for the role of pure syntax.

This conclusion, however, is called into question by the findings of a recent study by Ziegler et al (2019), which suggests that "syntactic priming" effects may not be purely syntactic. Almost certainly the study that is most often cited as evidence of purely syntactic priming is that of Bock and Loebell (1990). In this study, passive sentences such as *The construction worker was hit by the bulldozer* were primed by intransitive locative (i.e., non-passive) sentences such as *The 747 was landing by the airport's control tower*, providing evidence for a level of syntactic representation of the (approximate) form *[S [NP] [VP [AUX] [V] [PP [P] [NP]]]]*. In a high-powered modified replication of Bock and Loebell (1990), Ziegler et al (2019) found that this apparently-syntactic priming effect was driven solely by the lexical item by, which was both necessary and sufficient for priming to occur. That is, no priming of passives occurred following locatives that lacked by (e.g., *The 747 was landing next to* [c.f. *by*] *the airport's control tower*). Conversely, priming of passives did occur following active locative sentences with by (e.g., *The pilot landed the 747 by the control tower*).

Note, however, that hearing the by phrase is not always necessary for priming of passives: Messenger, Branigan & McLean (2011) showed that children and adults produced more 'full' passives (e.g., *The king was scratched by the tiger*) following short passive primes (e.g., *The girls are being shocked*) that did not contain the by phrase, than following active primes. These findings imply an underlying syntactic element of syntactic priming, but Ziegler et al's (2019) findings do highlight the importance of lexical factors.

Indeed, although – to our knowledge – Ziegler et al (2019) is the first study to demonstrate that priming is influenced by closed-class lexical items (here, *by*), at the level of the verb, the so-called *lexical-boost* effect is well accepted in the literature (see, for example, the meta-analysis of Mahowald, James, Futrell & Gibson, 2016). This is the phenomenon that priming effects are increased if the same verb appears in the prime and target sentence (e.g., between *The vase was **broken** by the ball* and *The window was **broken** by the hammer*).

Summarizing the current state of the literature, then, adult speakers' representation of the passive appears to contain – and hence priming, production and comprehension are sensitive to – (a) purely-syntactic information (Messenger et al, 2011, 2012; the present study), (b) semantic information (Ambridge et al, 2016; Aryawibawa & Ambridge, 2018; Bidgood et al, 2020; Liu & Ambridge, 2021) and (c) lexical information (e.g., Mahowald et al, 2016; Ziegler et al, 2019).

This raises the question of what type of account could incorporate all of these different types of representations. One viable candidate here is usage-based models of language acquisition which assume that learners retain, and are influenced by, individual lexical strings even when they have formed more abstract representations too (e.g., Langacker, 1998; Abbot-Smith & Tomasello, 2006; Goldberg, 2006; Ambridge 2020a, 2020b).

In particular, Ambridge (2020b: 640) argues for an "abstractions made of exemplars" account under which "(a) we store all the exemplars that we hear (subject to attention, decay, interference, etc.) but (b) in the service of language use, re-represent these exemplars at multiple levels of abstraction, as simulated by computational neural-network models such as BERT, ELMo and GPT-3". Lexical effects are driven by low-level representations – at the lowest level, individual stored passives sentences – while effects of pure syntax are driven by the highest-level, most-abstract representations, that correspond – if only approximately – to traditional linguistic representations of the passive construction. Semantic effects are driven by mid-level representation that are more abstract than individual sentence exemplars but less abstract than the (approximate) passive construction representation. For example, although these representations notoriously defy intuitive explanation, one level might constitute separate, and relatively distinct, clusters of passives with *experiencer-theme* and *theme-experiencer* verbs. Indeed, there already exist computational models along

these lines which exhibit both syntactic priming effects and sensitivity to lexical overlap (e.g., Prasad, Van Schijn & Linzen, 2019; Johns, Jamieson, Crump, Jones & Mewhort, 2020). An interesting direction for future research would be to investigate whether these models can also simulate the semantic effects observed in previous studies of the passive.

Finally, on a methodological note, it is important to acknowledge that while the method used in this study has a long pedigree, there is something rather unnatural about presenting passive sentences with no prior discourse context. In more naturalistic settings, the passive is used when the Noun Phrase about which the speaker wishes to make some comment or assertion is already highly topical in the current discourse (e.g., *Have you heard the news about YouTube? It was bought by Google*). Utterances that violate this principle are infelicitous and difficult to process (e.g., *Have you heard the news about Google? YouTube was bought by it*; examples from Pullum, 2014: 64). It may well be the case, then, that the relative unnaturalness of the present context-free passives either boosted the overall rate of passive priming (on a prime-surprisal account whereby context-free passives are more surprising) or inhibited it (if participants were reluctant to produce passives with no such topicalization function); or perhaps both, perhaps for different participants. In ongoing re-search (Darmasetiyawan & Ambridge, in preparation) we are investigating the effect of discourse context on the relative acceptability of passive sentences similar to those used in the present study.

In the meantime, and to sum up, the present high-powered online replication of Messenger et al's (2012) passive priming study found strong evidence for syntactic priming, but only weak evidence for an influence of verb semantics. Future studies, ideally incorporating a computational modelling component, should seek to explain not only this finding, but the finding that semantic effects on the passive appear to vary quite dramatically according to the paradigm used to assess them (c.f., Ambridge et al, 2016; Bidgood et al, 2020). Given the importance of the passive construction as a test case, future work along these lines holds the promise of uncovering the representations that underlie humans' remarkable ability to produce and understand novel utterances.

Chapter 4: Balinese semantics

Rationale for Study 2 in chapter 4

Study 1 in Chapter 3 found that, at least when evaluated using a syntactic priming paradigm, the semantic effect observed on passive production, even when given a sufficiently-powered sample, is relatively small, which would seem to favour the claim of generativist accounts – adults' abstract representation of the passive is purely syntactic, and not semantically based. However, the study did not provide positive evidence against a semantic effect (if anything, a small amount of evidence for it); and indeed, a recent similar study (i.e., Bidgood, Pine, Rowland, & Ambridge, 2020) that used animations instead of pictures, and varied the verb-type of the target rather than prime verb, observed a significant semantic effect in their priming study.

These findings raise the possibility of between-method differences with regard to semantic effects on the passive, and also the possibility of studying such effects crosslinguistically. Based on the claim of generativist accounts, the abstract (and innate UG) syntactic rules for the passive should be applicable to other languages as well. Based on the claim of constructivist accounts, the semantic-affectedness effect for the passive should also be found in other languages. Thus, the present Study 2 built of the findings of recent studies in other languages using a similar grammaticality judgment experimental paradigm (i.e., Indonesian: Aryawibawa & Ambridge, 2018; Mandarin: Liu & Ambridge, 2021). Both of these studies found a significant semantic effect, favouring the constructivist accounts of adult passive representation, contrary to the findings of Study 1 in Chapter 3.

Although different languages will of course have subtly different abstract (syntactic) representations of the passive (at least according to the constructivist approach), and although not all languages have a passive construction, for those that do, similar semantic effects should be manifest through the use of a similar grammaticality-judgment method. A particularly interesting feature of Balinese is the existence of four different passives (*-a*, *ma-*, *ka-*, and basic passives), which were used as stimuli alongside one active sentence type in a grammaticality judgment task. As for the previous crosslinguistic studies we are replicating, a semantic rating task was conducted with Balinese adults to provide the affectedness measure. The results of this

experiment bear not only on the generativist versus constructivist debate, but also on some of the major issues considered in the Balinese adult linguistics literature (i.e., the existence of non-canonical passives and the role of basic passives in Balinese).

The present Study 2 has been published in *Collabra: Psychology* (Darmasetiyawan & Ambridge, 2022).

1.0 Introduction

A central question in the cognitive sciences is the nature of speakers' linguistic representations; in particular, the syntactic representations that allow them to construct sentence-level utterances (e.g., *The man was surprised by the woman*). The goal of this paper is to use psycholinguistic data from an understudied language, Balinese, to bring some evidence to bear on this debate. Although, on the surface, it is hard to imagine a more "niche" topic than Balinese syntax, the debate in this domain is a test case for a wider debate regarding linguistic representations, and a still-wider debate regarding human representations in general; a debate with implications as far-ranging as how best to build self-driving cars (e.g., Marcus, 2018).

The debate is this: Is human knowledge best captured in terms of (a) symbolic categories and deterministic rules for manipulating them or (b) probabilistic knowledge that is built up gradually on the basis of the input? For example, when building an Artificial Intelligence to simulate the knowledge of human drivers, the first approach would define a pedestrian in terms of necessary and sufficient features (e.g., living; human), and specify a number of rules relating to them (e.g., IF pedestrian is in front of vehicle THEN stop; IF pedestrian is on the sidewalk THEN continue). Importantly, these symbolic categories (e.g., pedestrian) and rules (IF…THEN…) are hard-wired into the system (although they may also be finessed by some learning). The second, probabilistic approach eschews hard-wired categories and rules in favour of input-based learning: The information from all of the car's sensors is fed into a giant "deep learning" computational model, which is "rewarded" for successful outcomes (e.g., a safe trip) and "punished" for unsuccessful ones (e.g., hitting a pedestrian). Over time, the model builds internal representations that (hopefully!) *approximate* rules like

"IF pedestrian is in front of vehicle THEN stop", but these representations remain fuzzy and probabilistic.

In terms of human linguistic representations, the first approach posits (possibly hard-wired) categories such as Noun Phrase (e.g., *The woman*) and Verb Phrase (*surprised the man*), and rules for combining them into sentences (e.g., Sentence = Noun Phrase + Verb Phrase). The second approach assumes that speakers instead generalize across similar sentences in the input (e.g., *The woman surprised the man; The boy surprised the girl*) and arrive at representations that *approximate* the rule-based ones, but remain fuzzy and probabilistic (often called "constructions").

In the present article, we will call the first approach the "pure syntax" view. In more formal terms, this view sees syntax (roughly speaking, the set of procedures for building sentences) as "a computational system that interfaces with both semantics and phonology but whose functioning (that is the computations that are allowed by the system) is not affected by factors external to it" (Adger, 2017: 2). This view encompasses both traditional Chomskyan accounts (Chomsky, 1993; Newmeyer, 2003; Culicover et al, 2005; Branigan & Pickering, 2017), and "simpler syntax" accounts (Pollard & Sag, 1994; Culicover & Jackendoff, 2005; Branigan & Pickering, 2017: 8), all of which posit a "syntactic level of representation [that] includes syntactic category information but not semantic information…or lexical content". For example, a passive utterance such as *The man was surprised by the woman* might be formed using (very approximately) the syntactic representation *[S [NP] [VP [AUX] [V] [PP [P] [NP]]]]* (from Branigan & Pickering, 2017: 8). The details of these accounts are not important for our purposes – and, in any case, vary from theory to theory – the point is that they share the assumption that speakers put together sentences using formal rules that make no reference to semantic information; for example, to the meaning of the particular verb used (e.g., *surprised, punched* etc.)

In contrast, what we will call "semantics-based" approaches (e.g., Goldberg, 1995; 2006; Langacker, 2008) assume that sentence-level constructions (like all constructions) are pairings of form and functions. At the form level, these constructions approximate the representations posited by traditional accounts. Importantly, however, each construction is additionally associated with a prototype function or semantics. For example, in the case of the passive construction (e.g., *The man was surprised by the woman*), the associated semantics are such that

[B] (mapped onto the surface subject [of a passive]) is in a state or circumstance characterized by [A] (mapped onto the by-object or an understood argument) having acted upon it. (Pinker, Lebeaux & Frost, 1987).

What this means, in simple terms, is that the prototypical passive sentence is one in which the SUBJECT (usually the first-mentioned entity) is highly *affected* by the relevant action. For example, *The referee was punched by one of the fans* (example from Bock, 1986) is a prototypical passive, because the referee is likely to have been highly affected by having been punched. In contrast, a sentence such as *The referee was remembered by one of the fans* strikes most speakers as somewhat awkward, precisely because – if Pinker et al (1987) are correct – the referee is unlikely to have been affected at all by this remembering event (indeed, he may well remain entirely oblivious to it). Furthermore, a sentence such as *$10 was cost by the book* (c.f., the active equivalent *The book cost $10*) strikes most speakers as wholly ungrammatical, precisely because – if Pinker et al (1987) are correct – there is no possible reading under which $10 is "affected" by "having the book cost it". When we refer to degree of *affectedness* in the present article, this is what we mean.

The English passive has long constituted something of a test-case for this debate between *pure-syntax* and *semantics-based* approaches to linguistic representation. The findings of syntactic priming studies with adults and children have generally provided support for the pure-syntax approach. For example, Bock (1986) found that participants were more likely to produce passive than active picture descriptions (e.g., *The church is being struck by lightning* vs *Lightning is striking the church*) after repeating passive, rather than active prime sentences (e.g., *The referee was punched by one of the fans* vs *One of the fans punched the referee*). Subsequent studies have confirmed that this passive priming effect is robust, even in the absence of semantic and/or lexical overlap between the prime and target sentences (as in the examples above). A recent meta-analysis (Mahowald, James, Futrell & Gibson, 2016) of 74 individual passive priming studies found an overall log-odds ratio of 0.52, indicating that passives were 1.68 times as likely following a passive versus active prime.

Such findings have generally been taken as evidence for *pure-syntax* approaches (e.g., Branigan & Pickering, 2017), since the priming effect does not

appear to require a prime sentence that is consistent with the putative semantics of the construction. For example, Messenger, Branigan, McLean and Sorace (2012) found no evidence of increased priming following *agent-patient* and *theme-experiencer* primes (e.g., *The man was chased/surprised by the woman*) as opposed to *experiencer-theme* primes (e.g., *The man was missed by the woman*). Semantics-based accounts would seem to predict the presence of such an effect, on the basis that *theme-experiencer* passives are less consistent with the semantics of the *The man* being "in a state or circumstance characterized by… [*The woman*]… having acted upon it". A recent high-powered replication of Messenger et al (Darmasetiyawan, Messenger & Ambridge, 2022) largely supported the original finding: Although the data were, according to a Bayes Factor analysis, more consistent with the presence of a semantic effect than its absence, the observed effect was tiny, compared with a very large overall priming effect.

A number of other findings, on the other hand, would seem to constitute evidence for semantics-based over pure-syntax approaches. Using a modified version of Messenger et al's (2012) method, specifically varying the semantics of the prime rather than target verb, Bidgood, Pine, Rowland and Ambridge (2020) and Ambridge, Bidgood and Thomas (2021), found that adults and children indeed produced fewer experiencer-theme passives (e.g., *The man was missed by the woman*) than the other types. Bidgood et al (2020) further showed that this disadvantage for experiencer-theme passives extended to a forced-choice comprehension task; again, for both adults and children.

Of more direct relevance to the present study, Ambridge, Bidgood, Pine, Rowland and Freudenthal (2016) showed that independent ratings of verbs' "affectedness", designed to capture the putative semantics of the passive construction, predicted the grammatical acceptability of passives in a judgment task. Crucially, while a similar effect was also observed for actives (which also prototypically convey some degree of "affectedness"), the effect was bigger for passives, as revealed by a significant interaction of the semantic affectedness predictor by rated sentence type (i.e., passive/active).

According to the World Atlas of Language Structures, almost half of documented languages (162/373=43%) have a dedicated passive construction (https://wals.info/feature/107A#3/49.04/76.64). Yet all but a handful of the studies

discussed above have been conducted in English. Aryawibawa and Ambridge (2018) and Liu and Ambridge (2021) therefore set out to replicate the adult acceptability judgment study of Ambridge et al (2016) in Indonesian and Mandarin respectively. For Indonesian, the predicted semantic effect was observed for (canonical) passives (as in Ambridge et al, 2016, a smaller effect was also observed for actives), but not for the so-called "noncanonical" passive, a topicalization construction that follows passive word order, but lacks passive (or active) morphology. A topicalization construction is one that "promotes" a particular noun phrase (e.g., "that dog") to the beginning of the sentence (i.e., to the usual SUBJECT position) in order to establish it as the topic or theme of conversation; i.e., "the thing we're talking about". For example, in English we might say

(I like most dogs but) that dog, I hate
(c.f., the non-topicalized form I *hate that dog*)

For Mandarin, the predicted effect was observed for (canonical) *BEI*-passives (and also *BA*- actives; a dedicated affectedness construction), but – again – not for a noncanonical topicalization construction with passive word order, nor for regular actives.

The aim of the present study is to extend this methodology to investigate the semantics of passive(-like) and active constructions in a fourth language: Balinese. Despite its geographical and linguistic proximity to Indonesian, Balinese is particularly interesting for our purposes, since it has four different passive constructions.

1.1 Balinese and Balinese Passives

Balinese belongs to the (West) Malayo-Polynesian language group, and like many west-Indonesian languages, shows remnants of the Austronesian voice system (Artawa, 2013). In common with many languages of this group, the basic unmarked form of the verb in canonical (i.e., "active") word order actually gives a SUBJECT-as-patient meaning. For example, a [SUBJECT] [VERB] [OBJECT] sentence with the

unmarked form of *tulud*, 'push' indicates not that the SUBJECT (here, *the man*) pushed the OBJECT (here, *the woman*), but vice versa

Nak muani ento tulud nak luh ento.
person male that push person female that.
(As for) the man, the woman pushed (him)

This "Objective Voice" construction (e.g., Arka, 2003), also called the "Basic Verb" construction (Artawa, 2013), is a relatively marked and unusual construction, which serves the pragmatic function of "fronting" the (would-be) OBJECT (Arka & Simpson, 1998: 6). That is, the Balinese sentence above is best translated not as simply "The woman pushed the man" but as "As for the man, the woman pushed him" or "It was the MAN that the woman pushed". Thus, although this construction clearly has some passive-like properties, it is usually considered to be a type of active construction (Akra, 2003; Artawa, 2013). At least one analysis, however (Kersten, 1984), treats this construction as a type of passive. In the present study, as detailed below, we use a variant of this Objective Voice/Basic Verb construction which includes a passive-like *by*-phrase (*teken*).

1.1.1 Canonical active (Active Voice) sentences

For the standard active meaning, a canonical [SUBJECT] [VERB] [OBJECT] transitive sentence, at least with an agent-patient verb, usually requires a "nasal prefix replacing the initial consonant" (Arka & Simpson, 1998: 6), *n-* (or *ng-*)

Nak muani ento **n**-ulud nak luh ento.
person male that push person female that.
The man pushed the woman.

1.1.2 Passive(-like) sentences

Turning to passives, the most common passive is the ***-a* passive** form, which usually requires a definite, known, volitional agent (Arka et al, 1998; Sujaya, Artawa, Kardana & Satyawati, 2019), expressed in a *by*-phrase with *teken*.

nak luh ento tulud-**a** teken nak muani ento.
person female that push-PASS by person male that.
The woman was pushed by the man

Arka (2003: 7) calls the *-a* passive the "low passive" because it originates in "low register" Balinese (i.e., informal, spoken Balinese, particularly in the mountainous regions), and developed from the third person pronoun *–(n)a*.

***Ka-* passives** are, according to Arka (2003: 6) "real passives (originally associated with high register, but currently also used for low register)". Pragmatically, they are often used to emphasize that the activity is non-volitional on the part of the agent Accordingly, the agent is often omitted, unlike for the *-a* passive (Udayana, 2013), though this is by no means obligatory (Arka, 2003).

nak luh ento **ka**-tulud (teken nak muani ento).
person female that PASS-push (by person male that).
The woman was pushed (*by the man*).

Similarly, ***ma-* passives** (which Arka, 2003: 242 calls "resultative" or "actorless" passives) are used to emphasize that the subject is an affected patient, with the agent deemed unimportant, and usually omitted (in fact, Arka, 2003: 242, goes so far as to say that the verb "does not allow an oblique Agent PP"). Nevertheless, because it is unclear whether this prohibition is categorical – and for consistency with the other passive stimuli – we include a *by*-phrase with *teken* (i.e., an "oblique Agent PP") in our *ma-* passive stimuli.

nak luh ento **ma**-tulud (*?teken nak muani ento).
person female that PASS-push (by person male that).
The woman was pushed (*by the man*).

The *ma-* passive is "resultative" in the sense that it allows "only verbs of high transitivity that give rise to a kind of result (e.g., a product or a transferable thing)…Verbs of 'low' transitivity, such as verbs of perception, do not take ma-" (Arka, 2003: 243). This notion of transitivity would seem to overlap with – though is not identical to – the notion of affectedness investigated in the present study. Shibatani and Artawa (2003:240) have argued that some *ma-* forms can be analysed as "middles" (e.g., *The man washed [himself]* or "antipassives" (e.g,. *I ate [the rice]*), though this analysis is somewhat controversial (Arka, 2003: 246).

The final construction that we include in this study is one that we term the **basic passive**. This follows the same PATIENT-VERB-AGENT order as the Objective Voice/ Basic Verb construction (Arka, 2003; Artawa, 2013) discussed above, but also includes a *by*-phrase (*teken*). That is, this construction follows the same word-order as *-a, ka-* and *ma-* passives, but lacks any kind of morphological marking (note the use of the basic form *tulud*, as opposed to the marked active form *nulud*):

nak luh ento tulud-ø teken nak muani ento.
person female that push by person male that.
The woman was pushed by the man

We have been unable to find any reference to this construction in the literature; only to the Objective Voice/Basic Verb construction (i.e., the version that lacks *teken*, but is otherwise identical). However, the first author – a native speaker of Balinese – considers this basic passive (a term of our own invention) to be grammatically acceptable (an intuition more-or-less borne out by the findings of the present study). Thus, we decided to include this version – rather than the version without *teken* – for consistency with the other passive stimuli.

As the above sketch of passive(-like) constructions in Balinese makes clear (see Table 4 for summary), there is some debate in the linguistics literature regarding exactly which constructions constitute "real" passives. From a psycholinguistic perspective, however, the point is moot: The prediction of the *semantics-based* approach is simply that at least one of these passives(-like) constructions will show a semantic affectedness effect similar to that already observed for English, Indonesian

and Mandarin; at least on the assumption that passive(-like) constructions show similar tendencies crosslinguistically.

Table 4. Summary of the Balinese constructions investigated in the present study.

	active	***-a* passive**	***ka-* passive**	***ma-* passive**	***Basic* passive**
Argument order	Agent-Patient	Patient-Agent	Patient-Agent	Patient-Agent	Patient-Agent
Nasal prefix replaces initial consonant?	Yes	No	No	No	No
Passive morphologically marked	NA	Yes	Yes	Yes	No
by-phrase with AGENT?	NA	Usually required, definite, known, volitional	Often (though not obligatorily) omitted	Usually (possibly obligatorily) omitted	Obligatory
Register	Both	Low	Originally high, now both	Both	Low, informal
Pragmatics	Neutral	Default passive expressing both PATIENT and AGENT	Non-volitional on the part of the AGENT	Resultative for the PATIENT; AGENT is unimportant	Unclear? Arguably "pure" topicalization with no additional "passivizing" function.

1.2 The present study

Thus, the main aim of the present study is to test a prediction that follows from semantics-based approaches to the passive; specifically, that at least one of the *-a*, *ka-*, *ma-* and basic passive constructions will show a semantic affectedness effect. On the assumption that the SVO active construction is also prototypically associated with affectedness – albeit to a lesser extent than passives – we would also expect the active

construction to show an affectedness effect; albeit a smaller one than observed for passives. Otherwise, we make no specific predictions regarding which constructions will show larger or smaller affectedness effects, and take an exploratory approach to statistical analysis.

A complicating factor in the present study (as compared with English, Indonesian and Mandarin) is that since, for consistency, all passives include a *by-* (*teken-*) phrase, we will presumably see lower acceptability ratings for *ka-* and, in particular, *ma-* passives, which disfavour the expression of the agent to a lesser (*ka-*) and greater (*ma-*) degree respectively. Nevertheless, unless such sentences are deemed so ungrammatical as to yield floor effects – this overall lowered acceptability would not seem to preclude semantic affectedness effects for *ka-* and *ma-* passives.

2.0 Method

2.1 Participants

Sample sizes of *N*=60 for the grammatical acceptability judgment task and *N*=20 (different participants) for the semantic rating task were chosen, based on the Indonesian and Mandarin studies of Aryawibawa and Ambridge (2018) and Liu and Ambridge (2021). All participants were native speakers of Balinese attending Udayana University in Bali, Indonesia. Although no formal language measures were taken, it can also be assumed that all participants had some exposure to Indonesian and English. Ethics approval was granted by the ethics committees of the University of Liverpool (Project Reference 5322) and Udayana University, and all participants gave informed written consent.

2.2 Grammatical acceptability judgment task

The grammatical acceptability judgment task was conducted online using the Gorilla.sc platform, and can be reviewed at https://app.gorilla.sc/openmaterials/257204. Forty-nine of the 72 verbs used across Ambridge et al (2016), Aryawibawa and Ambridge (2018) and Liu and Ambridge (2021) were used, since many of the original 72 (e.g., *listen* and *hear*) translate into a

single verb in Balinese (e.g., *dingeh*). Other verbs were dropped because they lack an equivalent single verb in Balinese (e.g., *dress* would be translated as *salukin penganggo*, 'put on clothes'). Each verb appeared in one active and four passive constructions (49x5=245 sentence types)

Active

Nak muani ento **n**-ulud nak luh ento.
person male that push person woman that.
The man pushed the woman.

Passive (-a/ka-/ma/-ø)

nak luh ento [tulud-a/ka-tulud/ma-tulud/tulud-ø] teken nak muani ento.
person woman that [push-PASS] by person male that.
The woman was pushed by the man

An additional 245 sentence types were created by reversing the agent and patient roles (*The man/The woman*) for a total of 490 unique trials (see Table 5 for details). Because this was deemed to be too many trials for a single participant, we created two counterbalance sets, containing (A) 250 trials (25 verbs x 5 sentence types x 2 agent/patient mappings) and (b) 240 trials (24 verbs x 5 sentence types x 2 agent/patient mappings), with each participant completing only one. Sentences were also created for seven practice trials (for which typical ratings were provided): translations of those used in the English, Indonesian and Mandarin studies described above.

Sentences were audio recorded by a native speaker of Balinese (the first author) and presented in random order, along with accompanying videos (again, the same as used in previous studies). Participants provided their ratings using a 10-point Likert scale on the Gorilla platform.

Table 5. Passive sentences used in the study. For brevity, (a) corresponding active forms are not shown and (b) only a single counterbalance condition is shown.

Balinese (passive) sentence	**English translation**

nak muani ento (ka-/ma-) kelid (a-/ø) teken nak luh ento	The man was avoided by the woman
nak muani ento (ka-/ma-) cegut (a-/ø) teken nak luh ento	The man was bitten by the woman
nak muani ento (ka-/ma-) kauk (a-/ø) teken nak luh ento	The man was called by the woman
nak muani ento (ka-/ma-) tingting (a-/ø) teken nak luh ento	The man was carried by the woman
nak muani ento (ka-/ma-) uber (a-/ø) teken nak luh ento	The man was chased by the woman
nak muani ento (ka-/ma-) getep (a-/ø) teken nak luh ento	The man was cut by the woman
nak muani ento (ka-/ma-) ulung (a-/ø) teken nak luh ento	The man was dropped by the woman
nak muani ento (ka-/ma-) daar (a-/ø) teken nak luh ento	The man was eaten by the woman
nak muani ento (ka-/ma-) tugtug (a-/ø) teken nak luh ento	The man was followed by the woman
nak muani ento (ka-/ma-) tulung (a-/ø) teken nak luh ento	The man was helped by the woman
nak muani ento (ka-/ma-) jagur (a-/ø) teken nak luh ento	The man was hit by the woman
nak muani ento (ka-/ma-) gisi (a-/ø) teken nak luh ento	The man was held by the woman
nak muani ento (ka-/ma-) gelut (a-/ø) teken nak luh ento	The man was hugged by the woman
nak muani ento (ka-/ma-) tanjung (a-/ø) teken nak luh ento	The man was kicked by the woman
nak muani ento (ka-/ma-) diman (a-/ø) teken nak luh ento	The man was kissed by the woman
nak muani ento (ka-/ma-) tujon (a-/ø) teken nak luh ento	The man was led by the woman
nak muani ento (ka-/ma-) tundik (a-/ø) teken nak luh ento	The man was patted by the woman
nak muani ento (ka-/ma-) kedeng (a-/ø) teken nak luh ento	The man was pulled by the woman
nak muani ento (ka-/ma-) tulud (a-/ø) teken nak luh ento	The man was pushed by the woman
nak muani ento (ka-/ma-) kocok (a-/ø) teken nak luh ento	The man was shaken by the woman
nak muani ento (ka-/ma-) teteh (a-/ø) teken nak luh ento	The man was squashed by the woman
nak muani ento (ka-/ma-) ajin (a-/ø) teken nak luh ento	The man was taught by the woman
nak muani ento (ka-/ma-) umbah (a-/ø) teken nak luh ento	The man was washed by the woman
nak muani ento (ka-/ma-) gugu (a-/ø) teken nak luh ento	The man was believed by the woman
nak muani ento (ka-/ma-) nyeh (a-/ø) teken nak luh ento	The man was feared by the woman
nak muani ento (ka-/ma-) engsap (a-/ø) teken nak luh ento	The man was forgotten by the woman
nak muani ento (ka-/ma-) dingeh (a-/ø) teken nak luh ento	The man was heard by the woman
nak muani ento (ka-/ma-) tawang (a-/ø) teken nak luh ento	The man was known by the woman
nak muani ento (ka-/ma-) demen (a-/ø) teken nak luh ento	The man was liked by the woman
nak muani ento (ka-/ma-) tingal (a-/ø) teken nak luh ento	The man was looked by at the woman
nak muani ento (ka-/ma-) tresna (a-/ø) teken nak luh ento	The man was loved by the woman
nak muani ento (ka-/ma-) kangen (a-/ø) teken nak luh ento	The man was missed by the woman
nak muani ento (ka-/ma-) inget (a-/ø) teken nak luh ento	The man was remembered by the woman
nak muani ento (ka-/ma-) tepuk (a-/ø) teken nak luh ento	The man was seen by the woman
nak muani ento (ka-/ma-) adek (a-/ø) teken nak luh ento	The man was smelt by the woman
nak muani ento (ka-/ma-) sadin (a-/ø) teken nak luh ento	The man was trusted by the woman
nak muani ento (ka-/ma-) ngerti (a-/ø) teken nak luh ento	The man was understood by the woman
nak muani ento (ka-/ma-) balin (a-/ø) teken nak luh ento	The man was watched by the woman
nak muani ento (ka-/ma-) gedeg (a-/ø) teken nak luh ento	The man was angered by the woman

nak muani ento (ka-/ma-) pedih (a-/ø) teken nak luh ento	The man was annoyed by the woman
nak muani ento (ka-/ma-) tenangin (a-/ø) teken nak luh ento	The man was calmed by the woman
nak muani ento (ka-/ma-) seneb (a-/ø) teken nak luh ento	The man was disgusted by the woman
nak muani ento (ka-/ma-) ganggu (a-/ø) teken nak luh ento	The man was distracted by the woman
nak muani ento (ka-/ma-) gugul (a-/ø) teken nak luh ento	The man was disturbed by the woman
nak muani ento (ka-/ma-) kagum (a-/ø) teken nak luh ento	The man was impressed by the woman
nak muani ento (ka-/ma-) sebet (a-/ø) teken nak luh ento	The man was saddened by the woman
nak muani ento (ka-/ma-) jerih (a-/ø) teken nak luh ento	The man was scared by the woman
nak muani ento (ka-/ma-) kesiab (a-/ø) teken nak luh ento	The man was surprised by the woman
nak muani ento (ka-/ma-) canden (a-/ø) teken nak luh ento	The man was teased by the woman

2.3 Semantic rating task

Participants rated, by completing an Excel spreadsheet, each of 49 verbs for each of 10 semantic properties (again, the same used in previous studies), using a 9-point scale:

(a) A causes (or is responsible for) some effect/change involving B, (b) A enables or allows the change/event, (c) A is doing something to B, (d) A is responsible, (e) A makes physical contact with B, (f) B changes state or circumstances, (g) B is responsible [predicted to have a negative relationship with passivizability], (h) It would be possible for A to deliberately [VERB] B, (i) The event affects B in some way, (j) The action adversely (negatively) affects B.

These were the same properties rated (in translation) in previous studies of English (Ambridge et al, 2016; Bidgood et al, 2020), Indonesian (Aryawibawa and Ambridge, 2018), and Mandarin Chinese (Liu and Ambridge, 2021), and ultimately derive from Pinker (1989). In order to ensure that passivizability did not affect participants' semantic ratings, passives were not mentioned in the task or study description. Instead, participants were asked to consider the verbs as used in the context A VERBs B. As in the previous studies outlined above, we used Principle Components Analysis (PCC; "principal" from the R package "psych"; Revelle, 2018) to combine the individual semantic feature ratings (means taken across the 20 participants) into a single measure of passive semantics.

Following the suggestion of an anonymous reviewer, we also considered creating two predictors based on questions that primarily target (1) the agent (a, b, c, d, e, h) and (2) the patient (f, g, i, j). However, a forced two-factor PCA did not yield a statistically significant fit to the data (*chi-square* =35.16 *p*=0.11, n.s.), unlike the considerably better automatically-selected single-factor PCA (*chi-square* =129.2, *p*=1e-12). This demonstrates that all questions were effectively "asking the same thing", and that it would therefore be inappropriate to create two separate predictors, which would inevitably be very highly correlated with one another.

Finally, it is important to note that, unlike Ambridge et al (2016), Aryawibawa and Ambridge (2018) and Liu and Ambridge (2021), we were not able to include as a control predictor the frequency of each verb in each construction, since no corpus of Balinese exists. However, we consider this to be only a minor limitation given that, in large part, the frequency of a particular verb in a particular construction is a consequence of its semantic computability with that construction: Almost by definition, speakers do not use verbs in constructions with which they are semantically incompatible.

3.0 Results

Figure 8 shows the mean ratings (on the 10-point scale) for each verb in each sentence construction, and the relationship between these ratings and the composite semantic affectedness predictor (in Standard Deviation units).

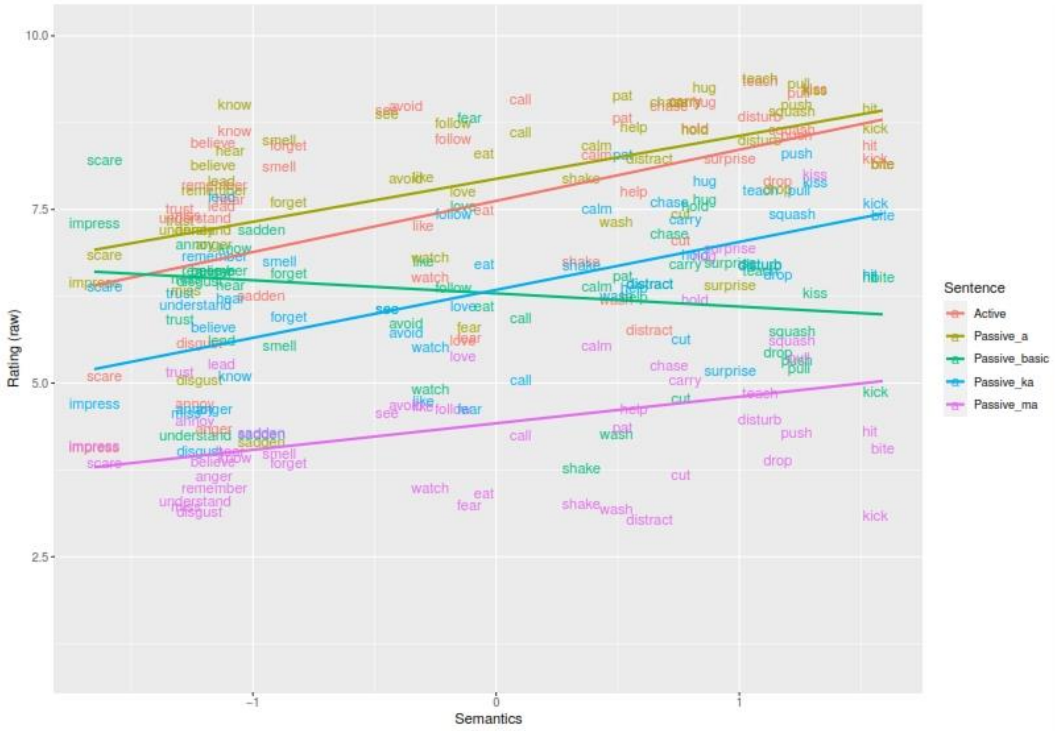

Figure 8: Mean ratings (on the 10-point scale) for each verb in each sentence construction as a function of the composite semantic affectedness predictor (in SD units). Lines show smooth conditional means (method=lm).

All analyses were conducted in the R environment (R Core Team, 2015). Because there remains a good deal of controversy regarding the relative merits of frequentist versus Bayesian analyses, we report both.

Frequentist mixed effects models built using the lme4 package (Bates, Mächler, Bolker, and Walker, 2015) would not converge without a very simple random effects structure that included no random slopes. We therefore used the JuliaCall package (Li, 2019) to interface with the JuliaStats Mixed Models package (Bates, Alday, Kleinschmidt, Calderòn, Noack, Kelman et al, 2021). Bayesian models equivalent to the "winning" frequentist models (i.e., those with the lowest AIC value) were built using the brms package (Bürkner, 2017). Given the exploratory approach taken in the present study, we used a wide-flat prior (M=0, SD=10, with all predictors scaled and centred).

All models had fixed effects for the composite semantics predictor ("Semantics"), Sentence Type ("Type": Active, Passive_a, Passive_ka, Passive_ma,

Passive_basic) and either (a) a slash (/) operator or * for the interaction. That is, the first set of models include the term "Type/Semantics" which evaluates the effect of semantics at each level of Type (i.e., for each sentence type) separately. This tests the prediction set out above that "at least one of the *-a, ka-, ma-* and basic passive constructions will show a semantic affectedness effect". The second set of models included the familiar interaction term "Type*Semantics" which compares the effect of Semantics at each level of Type (Passive_a, Passive_ka, Passive_ma, Passive_basic) to the effect of Semantics at the default, reference level of Type (Active). This tests the prediction set out above that "we would also expect the active construction to show an affectedness effect; albeit a smaller one than observed for passives". Sentence Type was coded using treatment (dummy) coding with "Active" as the reference level.

In terms of random effects, all models had random intercepts for Verb and Participant. Starting with models with both by-verb and by-participant effects for the interaction of Semantics/Participant or Semantics*Participant (explained below) we then simplified the models as follows (shown only for the "/" models), choosing the model with the lowest AIC value (and likewise for the "*" models).

Response ~ Type/Semantics +…
(1+Type/Semantics|Verb) + (1+Type/Semantics|Participant)
(1+Type+Semantics|Verb) + (1+Type/Semantics|Participant)
(1+Type/Semantics|Verb) + (1+Type+Semantics|Participant)
(1+Type+Semantics|Verb) + (1+Type+Semantics|Participant)
(1+Semantics|Verb) + (1+Type+Semantics|Participant)
(1+Type+Semantics|Verb) + (1+Type|Participant)
(1+Semantics|Verb) + (1+Semantics|Participant)
(1+Type|Verb) + (1+Type+Semantics|Participant)
(1+Type+Semantics|Verb) + (1+Type|Participant)
(1+Type|Verb) + (1+Type|Participant)
(1+Type|Verb) + (1|Participant)
(1+Semantics|Verb) + (1|Participant)
(1|Verb) + (1+Type|Participant)
(1|Verb) + (1+Semantics|Participant)
(1|Verb) + (1+Semantics|Participant))

For both the "/" and "*" models, the second model shown (in bold) had the lowest AIC value, and was therefore selected for reporting. All models can be found in Appendix 1 (frequentist) and Appendix 2 (Bayesian).

3.1 Frequentist models

Table 6 shows the frequentist model that evaluates the effect of semantic affectedness at each level of sentence type. As suggested by inspection of Figure 8, the *-a, ka-* and *ma-* passives all showed effects of semantic affectedness in the predicted direction at $p<0.01$ or better, as did the active construction. The basic passive, however, did not show any significant effect of semantics (and was not even in the predicted direction).

Table 6. Frequentist mixed effects model for Balinese grammatical acceptability judgment data: Effect of Semantics (affectedness) at each level of (sentence) Type ("/" model)

	Coef.	Std. Error	z	Pr(>z)
(Intercept)	7.65991	0.244239	31.36	<1e-99
Type: Passive_a	0.333311	0.157282	2.12	0.0341
Type: Passive_basic	-1.4027	0.304155	-4.61	<1e-5
Type: Passive_ka	-1.28255	0.250366	-5.21	<1e-6
Type: Passive_ma	-3.22044	0.293628	-10.97	<1e-27
Type: Active & Semantics	0.717873	0.177014	4.06	<1e-4
Type: Passive_a & Semantics	0.592678	0.192346	3.08	0.0021
Type: Passive_basic & Semantics	-0.162899	0.163316	-1.00	0.3185
Type: Passive_ka & Semantics	0.723026	0.162659	4.45	<1e-5
Type: Passive_ma & Semantics	0.409904	0.153814	2.66	0.0077

Table 7 shows the frequentist model that compares the effect of semantics for each passive construction to the effect of semantics for the active construction (the reference level). The only comparison that reached significance was between the active and the basic passive, which – as we have already seen – was not in the predicted direction. Thus, we do not have any evidence for the prediction set out above that the effect of semantic affectedness will be smaller for actives than for passives (nor, indeed, for the alternative possibility that it is greater).

Table 7. Frequentist mixed effects models for Balinese grammatical acceptability judgment data: Interaction of Semantics (affectedness) by (sentence) Type ("*" model)

	Coef.	Std. Error	z	Pr(>z)
(Intercept)	7.65986	0.243857	31.41	<1e-99
Type: Passive_a	0.332614	0.156772	2.12	0.0339
Type: Passive_basic	-1.40307	0.30386	-4.62	<1e-5
Type: Passive_ka	-1.28274	0.249807	-5.13	<1e-6
Type: Passive_ma	-3.21997	0.292928	-10.99	<1e-27
Type: Active & Semantics	0.71725	0.176724	4.06	<1e-4
Type: Passive_a & Semantics	-0.124587	0.141606	-0.88	0.3790
Type: Passive_basic & Semantics	-0.878953	0.268729	-3.27	0.0011
Type: Passive_ka & Semantics	0.00571206	0.151104	0.04	0.9698
Type: Passive_ma & Semantics	-0.306771	0.212352	-1.44	0.1486

Incidentally, the positive main effect for *a-* passives and the negative mean effect for *ka-*, *basic* and *ma-* passives indicates that, irrespective of verb semantics, *a-* passives were rated as significantly more acceptable than actives (probably due to the patient-focussed nature of the events), while *ka-*, *basic* and – in particular – *ma-* passives were rated as significantly less acceptable than actives (compare the heights

of the lines in Figure 8). Presumably this latter finding is due to the fact that, as noted in the Introduction, full passives (with a *by-/teken-* phrase) favour *-a* passives, with the other types dispreferred.

Before moving on to the Bayesian analyses, we used the performance package (Lüdecke, Mattan, Ben-Shachar, Patil, Waggoner & Makowsk, 2021) to test modelling assumptions (check model function). This latter step is particularly important, given that we fit a linear model to Likert-scale data which is technically not continuous linear interval-scale data.

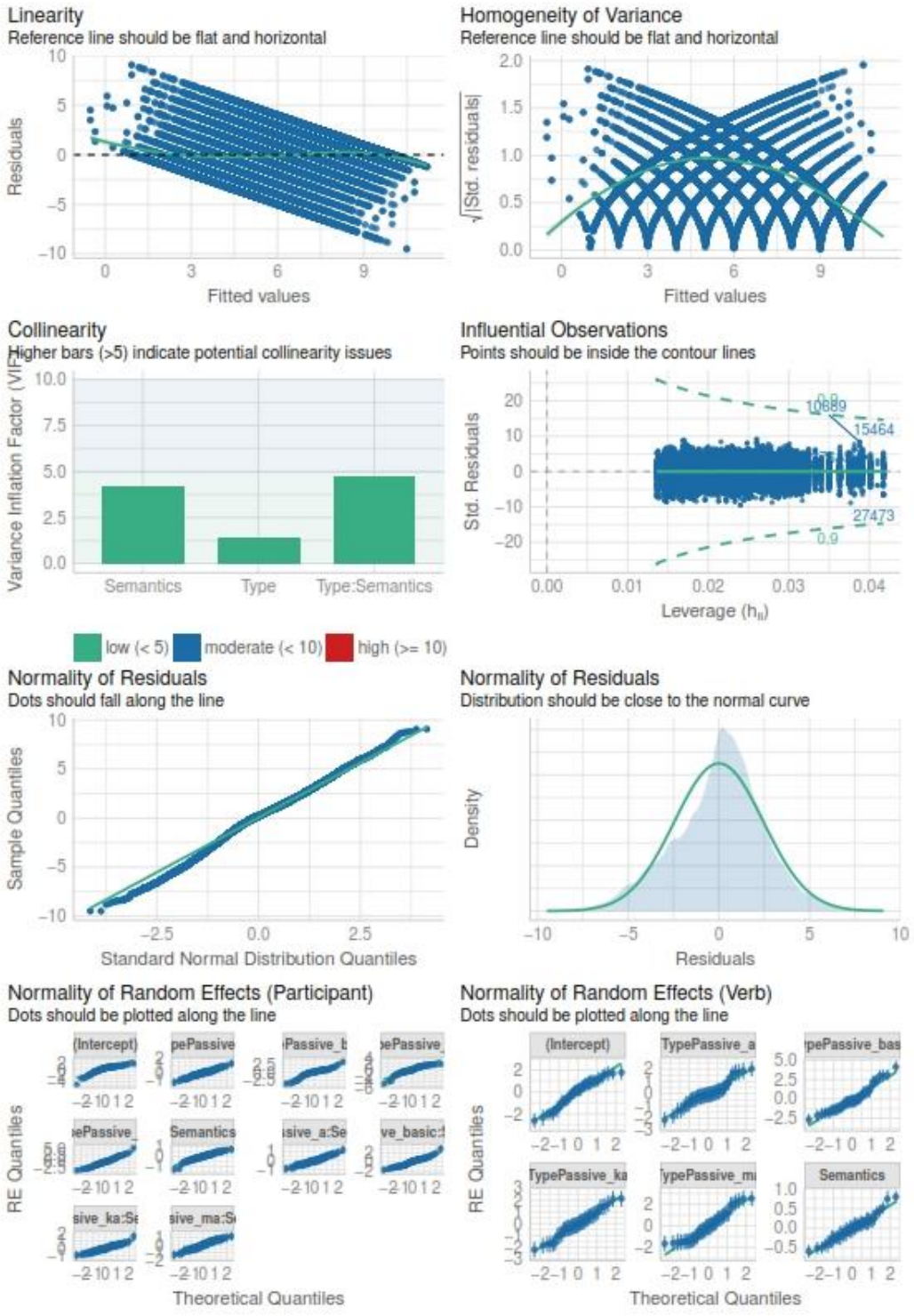

Figure 9. Tests of model assumptions.

Tests of the model's assumptions are shown in Figure 9. Inspection of Figure 9 reveals that all assumptions are met, with the only slight deviation regarding

homogeneity of variance: The line is broadly-speaking horizontal, but bends down at the end, revealing that the model is most accurate for ratings at the top end of the scale.

3.2 Bayesian models

The equivalent Bayesian models are shown in Table 8 ("/" model which estimates the effect of semantics for each sentence type) and Table 9 ("*" model which compares the effect of semantics for each passive construction to the effect of semantics for the active construction).

Table 8. Bayesian mixed effects model for Balinese grammatical acceptability judgment data: Effect of Semantics (affectedness) at each level of (sentence) type ("/" model)

Covariate	Estimate	Est. Error	1-95% CI	u-95% CI	B < > 0	Pmcmc
Intercept	7.62	0.24	7.15	8.09	1.00	0
TypePassive_a	0.32	0.16	0.00	0.64	0.97	0.03
TypePassive_basic	-1.34	0.30	-1.92	-0.75	1.00	0
TypePassive_ka	-1.26	0.26	-1.76	-0.76	1.00	0
TypePassive_ma	-3.19	0.29	-3.76	-2.61	1.00	0
TypeActive:Semantics	0.74	0.18	0.38	1.10	1.00	0
TypePassive_a:Semantics	0.62	0.17	0.28	0.95	1.00	0
TypePassive_basic:Semantics	-0.20	0.19	-0.57	0.17	0.85	0.15
TypePassive_ka:Semantics	0.71	0.17	0.36	1.08	1.00	0
TypePassive_ma:Semantics	0.39	0.18	0.04	0.74	0.98	0.02

Table 9. Bayesian mixed effects models for Balinese grammatical acceptability judgment data: Interaction of Semantics (affectedness) by (sentence) Type ("*" model)

Covariate	Estimate	Est. Error	1-95% CI	u-95% CI	B < > 0	Pmcmc
Intercept	7.62	0.24	7.15	8.09	1.00	0
TypePassive_a	0.32	0.16	0.00	0.64	0.97	0.03
TypePassive_basic	-1.34	0.29	-1.91	-0.76	1.00	0
TypePassive_ka	-1.27	0.26	-1.77	-0.76	1.00	0
TypePassive_ma	-3.19	0.29	-3.76	-2.61	1.00	0
TypeActive:Semantics	0.74	0.38	1.10	1.00	0	0
TypePassive_a:Semantics	-0.12	0.16	-0.43	0.18	0.78	0.22
TypePassive_basic:Semantics	-0.93	0.26	-1.44	-0.42	1.00	0
TypePassive_ka:Semantics	-0.03	0.17	-0.37	0.32	0.56	0.44
TypePassive_ma:Semantics	-0.35	0.20	-0.75	0.05	0.96	0.04

In both cases, the estimates and standard errors are all but identical for the frequentist and Bayesian models. The question of which effects are "statistically significant" is moot from a Bayesian perspective. For purely comparative purposes, however, we used the Lazerhawk package (https://github.com/m-clark/lazerhawk) to calculate a Bayesian equivalent to *p* values (column Pmcmc), defined as the proportion of posterior samples < 0 (for positive effects) or > 0 (for negative effects). Adopting the frequentist cut-off of <0.05, the Bayesian analysis yields the same pattern of "significant" and "nonsignificant" effects as the frequentist analysis (indeed, in many cases, the Bayesian *Pmcmc* values are similar to the frequentist *p* values). The same pattern holds if we define the Bayesian equivalent to "significance" as a 95% credible interval that does not cross zero.

3.3 Summary

In summary, the fitted statistical model met the necessary modelling assumptions reasonably well, and demonstrated that, as predicted, significant effects of the semantic predictor were observed in the expected (positive) direction for *-a*, *ka-* and *ma-* passives, but not non-canonical (basic) passives. Somewhat unexpectedly, a significant effect of a similar magnitude was also observed for actives, indicating that this construction too is prototypically associated with the semantic property of affectedness in Balinese.

4.0 Discussion

A long-standing question in cognitive science is the nature of speakers' utterance-level syntactic representations. Under traditional "pure syntax" approaches (e.g., Chomsky, 1993) these representations contain syntactic category information, but not semantic information. Under "semantics-based" approaches (e.g., Goldberg, 1995) both form and functional-semantic information are represented. Support for pure-syntax approaches comes from previous studies of passive priming (e.g., Branigan and Pickering, 2017; Messenger et al, 2012) which found robust priming effects that did not differ as a function of verb semantics (or did so to only a very minor degree; Darmasetiyawan et al, 2022). Support for semantics-based approaches comes from previous studies that have found greater passive production for verbs with a higher degree of semantic affectedness in English (Ambridge et al, 2016; Bidgood et al, 2020), Indonesian (Aryawibawa and Ambridge, 2018), and Mandarin Chinese (Liu and Ambridge, 2021).

The aim of the present study was to test for similar effects of semantic affectedness in Balinese. In a departure from previous studies of this type, verbs were rated in four different passive constructions, as well as the canonical active construction. As predicted by the semantics-based account, semantic effects were observed for three types of passives (*ka-*, *ma-*, and *-a*), as well as the active construction, but not for the Objective Voice/Basic Verb construction (Arka, 2003; Artawa, 2013) – what we term the *Basic Passive* – which follows passive word order, but lacks morphological marking.

In addition to providing crosslinguistic support for semantics-based approaches to the passive more generally (with effects observed for English, Mandarin, Indonesian and now Balinese), the present findings shed light on two language-internal questions discussed in the linguistics literature regarding the status of the Balinese passive constructions. First, the finding that Objective Voice/Basic Verb sentences showed, if anything, a negative correlation with affectedness provides support for the view that this construction is not a bona-fide passive construction (Arka, 2003; Artawa, 2013), given that all the other passives do display such an effect.

Second, given that the scenes depicted in the animations were mostly volitional (having humans in both roles), the pattern of ratings (*-a* > *ka-* & *Basic* > *ma-*) provides support for the view (e.g., Udayana, 2013) that *-a* passives are mainly used for volitional actions, *ka-* for non-volitional actions, and *ma-* passives in contexts when the agent is deemed unimportant, and is almost always omitted (hence the sense of ungrammaticality when, as in our test sentences, it is present). Note that although we did not specifically test for this pattern statistically it is clearly present in the data, given (see Table 8) that (a) *-a* passives are rated as significantly *more* acceptable than actives (the reference category) (*M*=0.33, *SE*=0.15, *p*=0.03), (b) *ka-* and *Basic* passives are rated as significantly *less* acceptable than actives (*M*= -1.28, *SE*=0.25, p=<1e-6; *M*= - 1.40, *SE*=0.30, *p*=<1e-5) and (c) *ma-* passives are also rated as significantly less acceptable than actives, but with a considerably larger effect size (*M*= -3.21, *SE*=0.29, *p*=<1e-27) than for *ka-* or Basic passives.

In conclusion, setting aside these language-internal debates, the present study has provided further support for semantics-based accounts of the passive crosslinguistically and – by extension – for semantics-based accounts of syntactic knowledge more generally. Future research should seek to reconcile the apparent discrepancy between studies of the present type which typically observe semantic effects (e.g., Ambridge et al, 2016; Aryawibawa and Ambridge, 2018; Liu and Ambridge, 2021; Bidgood et al, 2021) and syntactic priming studies which typically do not (e.g., Messenger et al, 2012; Darmasetiyawan et al, 2022). Assuming both types of findings stand up to further experimental scrutiny, any successful account of the nature of speakers' syntactic representations will have to explain both semantics-free and semantics-based syntactic knowledge.

Chapter 5: Sentence acceptability scenarios

Rationale for Study 3 in chapter 5

Study 2 in Chapter 4 found that a significant effect of verb semantics when studying Balinese speaking adults' passive representation. As discussed earlier, the contrasting finding of this study (which favours the constructivist accounts) with Study 1 in English (which narrowly favours generativist accounts) implies that changes in methodology may affect the outcome of studies investigating representations of the passive (and presumably other constructions too).

The different findings of these two studies are not directly comparable because, as well as different methodologies, they use different languages. However, it is notable that the generativist account would seem to predict a lack of crosslinguistic differences – assuming that the syntactic representation of the passive is more or less the same across languages – that is, no semantic effects in either study.

What Study 1 and Study 2 have in common with each other, and with all the previous passive studies discussed in the introductory chapters is that they manipulate the extent to which each sentence is consistent with the semantics of the construction by manipulating the verb (though of course there were other changes to, including from pictures to animations, from the use of a priming to a grammaticality judgment method, and from English to Balinese). What no study has to our knowledge done previously is manipulate semantic affectedness using context. This is important for two reasons – first because studies of language rarely take context into account, although it is of course crucial in everyday language. Second because effects of context would seem to be clear evidence for a constructivist exemplar account in which all information is, in principle stored and relevant, over a generativist account based on autonomous syntax.

Therefore, this study uses different context scenarios (high and low-affectedness) along with the least acceptable passives from the previous studies in this thesis – passives *experiencer-theme* verbs (e.g., *see*) –to prevent ceiling effect in grammatical acceptability judgments. Holding the verb (and indeed the whole sentence) constant in this experiment can then investigate the role of context without any confounding effect from the semantics (or other aspects) of the utterances

themselves. In this study, 24 *experiencer-theme* passives each in two different scenarios were tested with 100 adults to observe any semantic context effects on their acceptability judgments. For example, for the passive sentence (e.g., *Jack was seen by Emily*) - and an active equivalent (*Emily saw Jack*) – the high and low-affectedness semantic context sentences were (a) "Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back" and (b) "Jack was looking for his friend Emily in the park". Notice how only the "high" affectedness context sentence sets up a scenario in which Jack is significantly *affected* (the meaning of the passive construction).

Study 3 in Chapter 5 provides evidence of a clear (if small) effect for semantic context on acceptability judgments with regard to adults' passive representation. Evidence from this study could be argued to support the role of context as a separate factor on its own (i.e., pragmatic or discourse, outside of syntax). But it would be more consistent with the findings of Study 1 and 2 (and other similar studies conducted previously) to incorporate these semantic effects into syntax (as was argued for these previous studies). Under this view, context forms part of the meaning that comprises language representation.

1.0 Introduction

How do humans make sense of the world? One tradition (Pythagoras, Plato, Aristotle, Descartes, Spinoza, Leibniz, Kant) argues that we follow formal logical rules that are highly abstracted away from the specifics of particular experiences. Another tradition (Aristotle, Aquinas, Bacon, Hobbes, Hume, Locke) argues that our knowledge is based solely or mainly on our experience with the world. To take a simple example, under the first approach, we might assign robins, sparrows and seagulls to the category BIRD and set up formal "rules" that apply to this *category* (e.g., lays eggs; has feathers). These rules allow us to make inferences about new category members that we may encounter, even if they are fairly atypical ones (e.g., penguins). Under the second approach, we might memorize facts and experiences concerning robins, sparrows and seagulls and generalize them to new exemplars (e.g., penguins) on the basis of some measure of similarity.

This debate has been played out in just about every area of human cognition. In the present article, we present some new evidence on this debate in the domain of language; specifically grammar or syntax. So how is grammatical knowledge represented?

Under the first approach, speakers store formal abstract rules that can be used to generate sentences. For example, simple SUBJECT VERB OBJECT transitive sentences in English (e.g., *The man kicked the ball*) can be generated by two rules. The first combines a VERB (e.g., *kicked*) and a NOUN PHRASE (e.g., *the ball*) to create a VERB PHRASE (e.g., *kicked the ball*). The second combines another NOUN PHRASE (e.g., *The man*) and the previously-created VERB PHRASE (e.g., *kicked the ball*) to create the final sentence (e.g., *The man kicked the ball*). Of course, this is a highly simplified presentation that glosses over many important details and differences between theories. But some variant of this approach is assumed by a large number of different theoretical approach to adult grammatical representations, including Government and Binding theory (Chomsky, 1981), Minimalism (Chomsky, 1993), Lexical Functional Grammar (e.g., Kaplan & Bresnan, 1982), Categorial Grammar (e.g., Ajdukiewicz, 1935)., Head Driven Phrase Structure Grammar (e.g., Pollard & Sag, 1987) and Dependency Grammar (e.g., Tesnière, 1959). Adopting the terminology of Newmeyer (2010), we group these theories as broadly *formalist* approaches.

Under the second approach, speakers store individual sentences that they hear (e.g., *The boy ate the cake; The dog chased the cat; Wendy pushed Bob*) and generalize across these exemplars to produce some kind of abstract *construction schema* or *slot-and-frame pattern* (e.g., [A] [ACTION] [B]), paired with a particular meaning (e.g., 'A does something to B'). Speakers produce new sentences (e.g., *The man kicked the ball*) by inserting the relevant words into the relevant construction slots. (We need not concern ourselves here with the debate over whether these schemas are stored in the brain in some sense or are just a kind of metaphor for on-the-fly generalizations that speakers make across stored exemplars; see Ambridge 2020a, 2020b for an extensive discussion). Again, this is a simplified presentation that glosses over differences between individual theories including "Berkley" Construction Grammar (e.g., Fillmore & Kay, 1993), Sign Based Construction Grammar (e.g., Boas & Sag, 2012), Cognitive Grammar (Langacker, 1987), Goldbergian/Lakovian Construction

Grammar (e.g., Lakoff, 1987; Goldberg, 1995), Radical Construction Grammar (Croft, 2001), Embodied Construction Grammar (Bergen & Chang, 2003) and Fluid Construction Grammar (e.g., Steels, 2011). Adopting the terminology of Newmeyer (2010), we group these approaches as broadly *functionalist* approaches (although we agree with Newmeyer that few formalist linguistic theories entirely reject functionalism, and vice versa).

1.1 Formalist (lexicalist) vs Functionalist (construction-based) approaches

The difference between these approaches is summarized by Müller (2020: 587) as follows:

> a rather crucial aspect when it comes to the comparison of…theories…[is] whether sentence structure, or rather syntactic structure in general, is determined by lexical information or whether syntactic structures have an independent existence (and meaning) and lexical items are just inserted into them.

Consider, for example, the phenomenon that some verbs can appear in both intransitive and transitive sentences (e.g., *The ball rolled; The man rolled the ball*) while others can appear in intransitive sentences only (e.g., *The boy laughed*; c.f., **The man laughed the boy*). Under formalist approaches, this is – as Müller (2020) puts it – "determined by lexical information". What this means is that the speaker's lexicon – or "mental dictionary" – lists the sentence frames in which each particular verb can appear: intransitive (SUBJECT VERB) and transitive (SUBJECT VERB OBJECT) for *roll*, but only *intransitive* for laugh. This is sometimes referred to as a verb's *valance* (or *valency*); a term borrowed from chemistry. Notice that semantics – the meaning of the verb – plays no direct role here. It plays an indirect role, in that verbs with similar meanings (e.g., *laugh, chuckle, giggle*) tend to be similar in terms of the frames listed in their lexical entries. But this tendency is not represented anywhere in the grammar. Importantly, valence is deterministic not probabilistic: Either the lexical entry for a given verb contains a valency frame with both a SUBJECT and an OBJECT (e.g., *roll*) or it does not (e.g., *laugh*).

Under functionalist approaches, the phenomenon that particular verbs are restricted to particular sentence frames is determined by the meaning of the structure, for this example the SUBJECT VERB OBJECT transitive construction. *Roll* can be inserted into this construction (e.g., *The man rolled the ball*), because its meaning (a form of caused motion) is compatible with the meaning of the construction (very roughly speaking, 'A does something to B'). *Laugh* cannot (e.g., **The man laughed the boy*) because its meaning (an internally-caused action on the part of B) is not compatible with this construction meaning. That is, semantics plays a central, and direct, role in determining sentence structure. It also plays a probabilistic role: The meaning of a verb can be *somewhat* compatible with the meaning of the construction. For example, Bidgood, Pine, Rowland, Sala, Freudenthal and Ambridge, (2021) found that participants gave sentences like *The boy vanished the card* an intermediate acceptability rating on the basis that *vanish* – as determined in a separate semantic-rating task – is only *somewhat* compatible with the meaning of the construction (very roughly speaking, 'A does something to B').

1.2 Formalist and Functionalist approaches to the passive

One construction that has been frequently studied with regard to this debate (though not always framed in these particular terms) is the passive; mainly, but not exclusively, the English passive. Functionalist, construction-based approaches assume that the passive construction (like all constructions) has a meaning in and of itself, above and beyond that of the items in any particular passive sentence. This meaning, which we will call *affectedness* for short, is neatly summarized by Pinker, Lebeaux and Frost (1987: 249; see also Pinker, 1989[i]).

> [B] (mapped onto the surface subject [of a passive]) is in a state or circumstance characterized by [A] (mapped onto the by-object or an understood argument) having acted upon it.

Functionalist, construction-based approaches therefore predict that the more a given verb has the meaning of "affectedness" the greater its acceptability (and production probability, and ease of comprehension) in the passive construction.

Formalist, lexicalist approaches would not seem to be able to explain this type of gradient effect: If the passive construction is listed amongst the possible valence frames for a particular verb, the passive will be grammatically acceptable. If it is not (e.g., for unpassivizable verbs such as *cost*) it will not (e.g., **$5 was cost by the book*). But amongst verbs that are passivizable – i.e., that *do* have the passive listed in their lexical entry – there is no mechanism in formalist, lexicalist approaches that would give rise to continuous semantic-compatibility effects. Significantly, Chomsky (1993:4) rules out not only the existence of a passive construction *with a particular meaning*, but of a passive construction in general:

> Constructions such as...[the] passive remain only as taxonomic artifacts, collections of phenomena explained through the interaction of the principles of UG, with the values of the parameters fixed.

Even more explicitly, when Branigan and Pickering (2017: 8) argue that "syntactic representations do not contain semantic information" or that "Like adults, 3- and 4-year-olds appear to have abstract syntactic representations that are not specified for lexical or thematic content" (p.16), two of the four studies they cite as evidence are studies of the passive (Bencini & Valian, 2008; Messenger et al., 2012).

1.3 Previous studies of the passive

In summary, then, functionalist, construction-based approaches therefore predict that the more a given verb has the meaning of "affectedness" the greater its acceptability (and production probability, and ease of comprehension) in the passive construction. Formalist lexicalist approaches do not. So, what does the evidence say (focussing mainly here on studies with adults)?

In syntactic priming studies, participants hear (and sometimes repeat) a priming sentence (e.g., a passive such as *Jack was seen by Emily*) paired a picture/animation and are then asked to describe a new picture/animation. A *syntactic priming* effect is seen when participants use the same syntactic structure as the prime sentence (e.g., a passive such as *Bob was hit by Wendy*) as opposed to a suitable alternative structure (e.g., an active such as *Wendy hit Bob*). Syntactic priming studies (Mahowald, James,

Futrell & Gibson, 2016, for a review and meta-analysis) are generally taken as evidence for the formalist/lexicalist approach, since participants typically show priming effects – including for the passive – regardless of the particular verb used in the prime; regardless, that is, of the prime verb's semantic compatibility with the (putative) meaning for the construction. Particularly relevant here is the study of Messenger et al (2012) who showed that passives (e.g., *Bob was hit by Wendy*) were equally primed by passives with *agent-patient, theme-experiencer* and *experiencer-theme* verbs (e.g., *Jack was kicked/frightened/seen by Wendy*), even though verbs of the latter type are less compatible with the (putative) meaning of the passive construction. A recent high-powered replication of this study (Darmasetiyawan, Messenger & Ambridge, 2022) largely echoed this conclusion, finding only very weak evidence (Bayes Factor = 2.1) for the prediction that theme-experiencer passives (e.g., *Jack was frightened by Emily*) would yield greater passive priming effects than experiencer-theme passives (e.g., *Jack was seen by Wendy*), since the former are more compatible with the putative semantics of the construction.

While findings from syntactic priming studies have generally supported the formalist/lexicalist view, findings from production, comprehension and judgment studies have generally supported the functionalist/constructivist view. For production, Bidgood, Pine, Rowland and Ambridge (2020) showed that adults (and children) were more likely to produce passives with *agent-patient* and *theme-experiencer* verbs (e.g., *Jack was kicked/frightened by Emily*) than with *experiencer-theme* verbs (e.g., *Jack was seen by Emily*) (see Ambridge, Bidgood & Thomas, 2021; Jones, Dooley & Ambridge, 2021, for similar findings with children). For comprehension, Bidgood et al (2020) showed that adults (and children) were faster/more likely to point to a matching picture (rather than a foil with the roles reversed) for *agent-patient* and *theme-experiencer* passives (e.g., *Jack was kicked/frightened by Emily*) than for *experiencer-theme* verbs (e.g., *Jack was seen by Emily*). Although we focus here on adult studies, similar findings have been reported in numerous studies with children; see Nguyen & Pearl, 2021, for a meta-analysis). Ambridge, Bidgood, Pine, Rowland and Freudenthal (2016) reported similar comprehension findings for adults using a continuous measure of verb semantics (described in more detail below), rather than a categorical split between *agent-patient, theme-experiencer and experiencer-theme* verbs.

Of most relevance to the present study – which uses this same method – are grammatical acceptability judgment studies. Ambridge et al (2016) asked adults to rate a set of verbs for the extent to which they exhibit each of 10 semantic properties, designed to capture Pinker et al's (1987) notion of affectedness: *(a) A causes (or is responsible for) some effect/change involving B, (b) A enables or allows the change/event, (c) A is doing something to B, (d) A is responsible, (e) A makes physical contact with B, (f) B changes state or circumstances, (g) B is responsible [predicted to have a negative relationship with passivizability], (h) It would be possible for A to deliberately [VERB] B, (i) The event affects B in some way, (j) The action adversely (negatively) affects B*). These predictors were then combined into a single predictor of "passive-compatible verb semantics". Ambridge et al (2016) found that this continuous measure of semantic affectedness significantly predicted verbs' rated acceptability in the passive construction (and, as noted above, speed in a forced-choice comprehension task). Importantly, although this semantic affectedness predictor also predicted verb's rated acceptability in the active construction (which has an overlapping construction meaning), the effect was bigger for actives (as demonstrated by a significant interaction). Subsequently, Aryawibawa and Ambridge (2018), Liu and Ambridge (2021) and Darmasetiyawan & Ambridge (2022) have replicated the judgment component of Ambridge et al (2016) for Indonesian, Mandarin and Balinese respectively.

1.4 The role of scenario/context

In summary, the findings from comprehension, production and judgment studies generally support the functionalist/constructivist prediction that passive sentences are more felicitous with *agent-patient* and *theme-experiencer* verbs (e.g., *Jack was kicked/frightened by Emily*) than with *experiencer-theme* verbs (e.g., *Jack was seen by Emily*), because the latter are less compatible with the "SUBJECT affectedness" semantics of the construction. The findings from priming studies generally support the formalist/lexicalist prediction that, provided the relevant verb is passivizable in a broad sense, all passives are created equal (or, at least, are equally good at priming other passives), regardless of the semantics of the verb.

Yet despite their differing findings, all of these previous studies have one thing in common: they manipulate semantic compatibility by manipulating the identity of the verb (e.g., *kick/frighten/see*). In the present study, we take a different approach, manipulating the semantics of the scenario/context, while holding the verb (and indeed the whole sentence) constant. Our prediction is that the same passive sentence (e.g., *Jack was seen by Emily*) will be rated as more acceptable when *Jack* is highly affected (e.g., "Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back") than in a more neutral scenario ("Jack was looking for his friend Emily in the park"). (As in previous studies, we predict a similar – though smaller – effect for active sentences, which also prototypically denote some degree of affectedness; e.g., Hopper & Thompson, 1984; Næss, 2007; Talmy, 1985; Ibbotson, Theakston, Lieven & Tomasello, 2012).

This prediction comes from a (modest) revision to theories of Construction Grammar that we propose here. Under this proposal, the grammatical acceptability of a particular sentence (e.g., *Jack was seen by Emily*) is not – unlike under standard Construction Grammar approaches – determined by the semantic compatibility between the construction frame ([A] was AFFECTED by [B]) and the verb (e.g., *see*) *per se*. Rather, the grammatical acceptability of a particular sentence (e.g., *Jack was seen by Emily*) is determined by the semantic compatibility between the construction frame and the particular *event* that the verb describes in context (e.g., a particular *seeing **event***). The advantage of this proposal (if it is indeed supported by the present findings) is that it naturally explains within a single framework effect of context on grammatical acceptability that are well known, but that are usually framed as some kind of "add-on" or additional factor.

For example, Schütze (1996: 13), explicitly rejects ("such conclusions are not justified") the conclusion that because "grammaticality judgments are susceptible to…context effects…that the grammar itself must have these properties, or that these properties must be part of the language-specific component of the brain". Keller (2000: 126) draws a distinction between context-independent and context-dependent linguistic constraints on grammatical acceptability: "A constraint is context-independent if it is immune to context effects, i.e., if its violation causes the same degree of unacceptability in all contexts. A constraint is context-dependent if the degree of unacceptability triggered by its violation varies from context to context".

Again, this approach separates out (a) the grammar (here, in the form of constraints) and (b) context as something separate that can affect the unacceptability of grammatical violations. As noted in Sorace and Keller (2005: 14), this is similar to Chomsky's (1964: 385) distinction between "sentences that are acceptable *without* requiring a specific context, and *ones* that are only acceptable in a specific context" (emphasis in original); a distinction they date back to Lenerz (1977) and Höhle (1982). Similar again is Müller's (1999: 782) proposal that "relative degrees of markedness can be empirically determined…by adhering to the number of context types in which the candidate [i.e., the sentence] is possible". Erteschik-Shir (2006) suggests a different split under which "violations of syntactic constraints cannot be graded, whereas violations of IS [information structure] constraints can be"[ii]. Again, the idea is that context does not enter into syntax *per se*, but only affects it indirectly; in this case via information structure.

1.5 The present study

The proposal that we set out and test in the present study is very different to those set out above, in that context effects are built directly into the syntax: The (graded, continuous) grammatical acceptability of a particular sentence (e.g., *Jack was seen by Emily*) is determined by the semantic compatibility between the construction and the particular *event* that the verb describes in context (e.g., a particular *seeing **event***). (It follows from this proposal that the semantics of the construction itself is also derived from the semantics of events described by individual instantiations of that construction encountered in the input. That is, the semantics of the passive construction – roughly characterized as "subject affectedness" – reflects an aggregation of the characteristics of individual events (either witnessed or imagined) that speakers have encountered paired with passive utterances). This proposal represents only a relatively small modification to functionalist/construction-based accounts which, by their very nature, emphasize the usage-based and context-dependent nature of syntax (and language more generally). But it represents a radical departure from formalist/lexicalist accounts, under which the lexical entry for a given verb either contains a passive frame or it does not; there is no room for the acceptability of *the same sentence* to vary

according to contextual factors (except, of course, by operating as an additional add-on outside of the grammar).

Finally, a note is in order regarding what we mean by "context". In the present study, we manipulate the scenario or context linguistically by presenting before the target sentence (e.g., *Jack was seen by Emily*) a context sentence (e.g., either "Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back" or "Jack was looking for his friend Emily in the park"). But this is only a methodological convenience, and should not be mistaken for a theoretical claim. In principle, the proposal that we set out here predicts that passive sentences will be rated as more acceptable in high- than low-affectedness scenarios, even if this is determined entirely extralinguistically (e.g., by using languageless videos to set up the relevant contexts).

2.0 Method

2.1 Participants

A preregistered (https://osf.io/4cdga/) sample size of N=100 (based on time/resource constraints) was chosen. All participants were adult (18+) native speakers from a student participation pool, who participated as part of a course requirement. Altogether, 109 participants were recruited. Seven were discarded for (as per our preregistration) failing a manipulation check: an instruction to give the highest/lowest possible rating on the 100-point scale (allowing for a 5-point tolerance). Two were discarded simply to comply with our preregistered plan to "recruit exactly 100 participants". The preregistration specified that "any participants who do not provide a response for every trial will be excluded and replaced", but this was not necessary. Ethics approval was granted by the ethics committee of the University of Liverpool (Project Reference 8173); all participants gave informed written consent.

2.2 Stimuli and Materials

The experiment was conducted using an online platform, Gorilla (https://app.gorilla.sc/). From the 72 verbs used by Ambridge et al (2016), we selected

24 *experiencer-theme* verbs (e.g., *see*), as these are generally deemed less acceptable in the passive construction than *agent-patient* and *theme-experiencer* verbs (e.g., *kick*, *frighten*), which – in our judgment – would have displayed ceiling effects on acceptability ratings that would mask any underlying effect of context. We created sentence stimuli (always with the arguments *Emily* and *Jack*) according to a 2x2 (sentence type x context) design, such that each verb appeared (a) in both a passive sentence (e.g., *Jack was seen by Emily*) and an active equivalent (*Emily saw Jack*) and (b) following both a high-affected and low-affected (neutral) context sentence (e.g., "Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back" vs "Jack was looking for his friend Emily in the park"). For each sentence, we created two counterbalance versions with the roles reversed (e.g., *Jack was seen by Emily; Emily was seen by Jack; Emily saw Jack; Jack saw Emily*), divided equally amongst participants. That is, all participants completed all 96 trials (24 verbs x 2 sentence types x 2 context types); all that varied between participants was the pairing of Jack and Emily with each verb (which was always consistent for a given verb for a given participant). The target and context sentences are shown (without counterbalancing) in Table 10.

Table 10. Passive and Active sentences in High-affectedness and low-affectedness (neutral) contexts

High affectedness context	Low affectedness (neutral) context	Passive target sentence	Active target sentence
Jack put on his best clothes for the party, hoping that Emily would notice him. Then	Jack got dressed and set off for the party, along with his sister Emily. Then	Jack was admired by Emily	Emily admired Jack
Jack had a very hard time to make anyone believe in what he said. Then	Jack, who has a reputation for honest, told a story of his trip abroad to all guests at the party. Then	Jack was believed by Emily	Emily believed Jack
Jack loved Emily and hoped that she felt the same; but an unfortunate incident happened. Then	Jack had no particular feelings for or against Emily; but an unfortunate incident happened. Then	Jack was disliked by Emily	Emily disliked Jack
Jack had been told by the judge that he risked prison if he frightened any more women. Then	Jack was trying on Halloween costumes and pulling scary faces. Then	Jack was feared by Emily	Emily feared Jack
Jack was very glad that his wife, Emily, had finally come out of her two-year coma. Then	Jack had never met Emily again after they graduated from college. Then	Jack was forgotten by Emily	Emily forgot Jack
Jack was trying really hard to make a good impression on Emily, until one day he got into a fight with her friend. Then	Jack didn't particularly like Emily, and one day got into a fight with her friend. Then	Jack was hated by Emily	Emily hated Jack
Jack was lost in the forest for almost two weeks and a search party, including Emily, was looking for him. Then	Jack was giving lecture at Emily's class. Then	Jack was heard by Emily	Emily heard Jack
Jack had suffered a life-threatening injury and was screaming for help. Then	Jack was messing around in class as usual. Then	Jack was ignored by Emily	Emily ignored Jack
Jack was worried on his first day, as he thought everyone there would be a stranger. Then	Jack wasn't worried when he turned up, as he assumed he'd see some familiar faces. Then	Jack was known by Emily	Emily knew Jack
Jack was hoping to land his dream job, but knew he would have to impress the Chief Executive, Emily. Then	Jack was popular with just about everyone in his class, and didn't really care what Emily thought of him. Then	Jack was liked by Emily	Emily liked Jack
Jack was sure that the judge, Emily, wouldn't hear his appeal, and he'd have to spend 50 years in prison. Then	Jack had to sing a song in front of Emily in the school assembly, but didn't care if she liked it or not. Then	Jack was listened to by Emily	Emily listened to Jack
Jack was very embarrassed by his terrible outfit, and hoped to sneak away without any of the girls seeing him. Then	Jack walked back into the office and held up the parcel for everyone to see. Then	Jack was looked at by Emily	Emily looked at Jack
Jack, a stray dog, would have to live the rest of his life in the kennels unless someone decided to take him home. Then	Jack was admired by pretty much all the girls in his class, not that he really cared. Then	Jack was loved by Emily	Emily loved Jack

Jack had been dumped by Emily and moved away, still hoping she would want him back. Then	Jack dumped Emily and moved away, hoping never to hear from her again. Then	Jack was missed by Emily	Emily missed Jack
Jack really didn't want to go back to prison, but took the money and tried to sneak past the security guard, Emily. Then	Jack, a celebrity, was often recognized in the street, and strolled past Emily without a second thought. Then	Jack was noticed by Emily	Emily noticed Jack
Jack was whispering to his friend about the time he had cheated on his wife, Emily. Then	Jack was talking loudly to his friend on the train with Emily, a stranger, sitting next to them. Then	Jack was overheard by Emily	Emily overheard Jack
Jack told his boss, Emily, that he was too sick to come in and then went to the pub, hoping nobody from work was there. Then	Jack went to the pub where he knew all the regulars, including Emily. Then	Jack was recognized by Emily	Emily recognized Jack
Jack chatted to his new boss Emily, hoping she had forgotten that he was the criminal who had robbed her 10 years ago. Then	Jack chatted to his new boss Emily, who he vaguely knew from their old school, though they hadn't had much to do with each other. Then	Jack was remembered by Emily	Emily remembered Jack
Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back. Then	Jack was looking for his friend Emily in the park. Then	Jack was seen by Emily	Emily saw Jack
Jack, a criminal on the run, was being hunted down by the Police's best sniffer dog, Emily. Then	Jack and Emily were trying on different perfumes and aftershaves. Then	Jack was smelt by Emily	Emily smelt Jack
Jack had bet Emily £500 that he would stick to his diet but, when he thought she was out of town, went to McDonalds. Then	Jack was trying to find his friend Emily in the crowd. Then	Jack was spotted by Emily	Emily spotted Jack
Jack knew that they'd all die unless everyone listened to him and followed his plan, no matter how crazy it sounded. Then	Jack was very well liked and respected, and everyone almost always went along with his suggestions. Then	Jack was trusted by Emily	Emily trusted Jack
Jack knew that his business would go bankrupt unless he could get his bank manger, Emily, to follow his complex investment plan. Then	Jack told Emily what their maths homework was, which was something very simple. Then	Jack was understood by Emily	Emily understood Jack
Jack was cheating on his girlfriend, Emily, with his neighbour, and sneaked out the house when he thought she was asleep. Then	Jack was doing his daily acoustic performance in the bar, and had invited his girlfriend, Emily. Then	Jack was watched by Emily	Emily watched Jack

2.3 Procedure

Participants were given the following onscreen instructions:

To do this task you must be a native speaker of English. If not, please do not complete the study.

> On each screen, you will see and hear a scenario sentence that sets the context and then a sentence describing an event. Please rate the grammatical acceptability of that second sentence (the one highlighted with red arrows), using the slider that you see below the sentence.
>
> Please be sure to rate the **grammatical acceptability** of the sentence and NOT (for example) whether the event that it describes is pleasant or unpleasant!
>
> NB: Acceptability is a sliding scale, not a yes/no judgment. Please be sure to use the whole of the scale. Acceptability is also a subjective judgment – there are no "right" or "wrong answers". Please rate the sentence pointed by the red arrow.
>
> It is important that you listen to the audio sentences, so make sure to have headphone or speakers and to turn the volume up.

Participants then completed the test trials, which involved rating each target sentence on a 100-point visual-analogue scale (see Figure 10). In order to guard against the possibility that participants might simply ignore the context sentence and proceed directly to rating the target sentence, both the context and target sentences were presented both onscreen and auditorily over headphones (using recordings made by the first author). The rating scale did not appear until the audio playback was complete, ensuring that participants heard – and presumably processed, to at least some degree – the context sentence. Since the study was conducted entirely online and without supervision, we cannot rule out the possibility that some participants muted the audio

playback or consciously ignored it. However, they would have had no time-saving incentive to do so, since the rating scale did not appear until audio playback (even if muted or ignored) was complete.

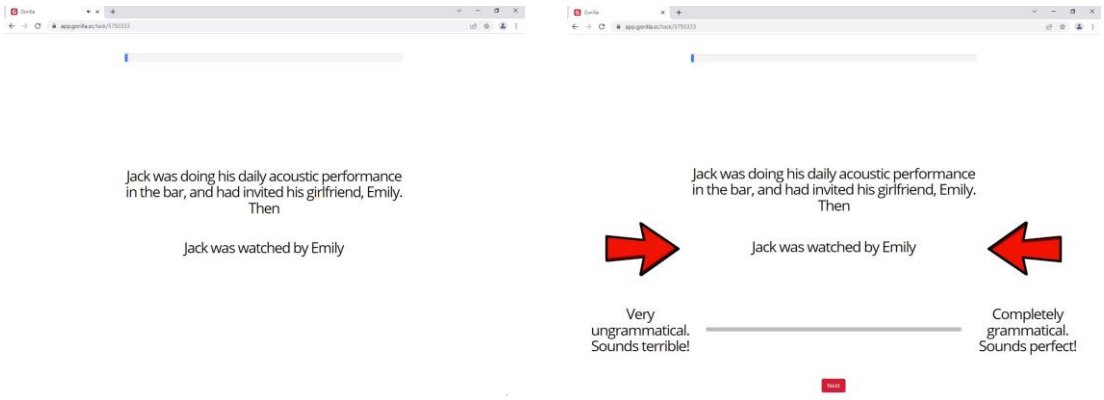

Figure 10. Experimental procedure. Note that the rating scale does not appear until audio playback is complete

2.4 Predictions

Our preregistered predictions (https://osf.io/4cdga/) were as follows:

- **Prediction 1**: For **Passive sentence** (SentenceType=="Passive"), participants will show a significant preference (i.e., higher grammatical acceptability – column "Response") for (identical) sentences with HighAffected than LowAffected contexts (column ContextType). This prediction is confirmed if (a) the means are in this direction and (b) the relevant contrast in the syntax below (SentenceTypePassive:ContextType1) yields a *p* value of <0.05.

- **Prediction 2**: For **Active** sentence (SentenceType=="Active"), participants will show a significant preference (i.e., higher grammatical acceptability - column "Response") for (identical) sentences with HighAffected than LowAffected contexts (column ContextType). This prediction is confirmed if (a) the means are in this direction and (b) the relevant contrast in the syntax below (SentenceTypeActive:ContextType1) yields a *p* value of <0.05.

- **Prediction 3**: Participants' preference for (identical) sentences with HighAffected over LowAffected contexts will be **GREATER** for Passive than Active sentences. This prediction is confirmed if (a) the means are in this direction and (b) the relevant contrast in the syntax below yield a *p* value of <0.05.

3.0 Results

Figure 11 shows participants' ratings for active sentences (left-hand pair) and passive sentences (right-hand pair) in high-affected (blue bars) and low-affected (red bars) contexts.

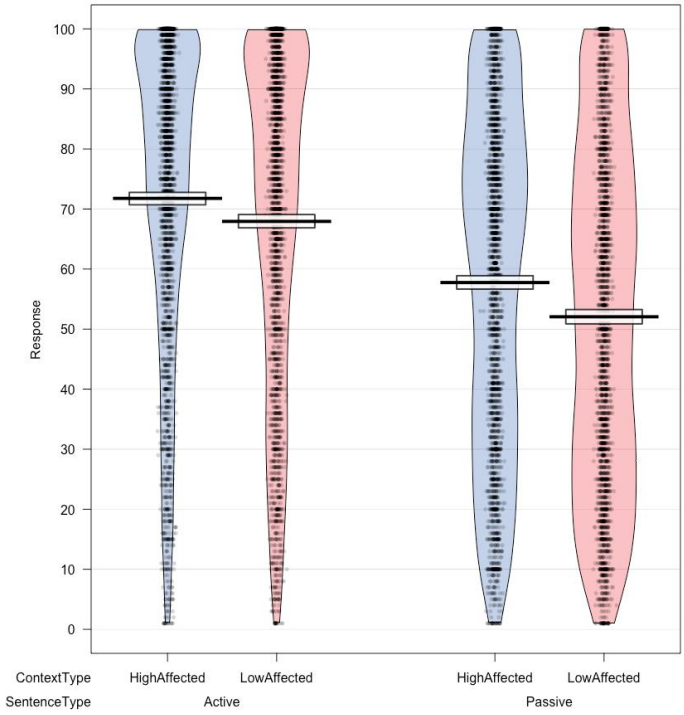

Figure 11. Participants' ratings for active sentences (left-hand pair) and passive sentences (right-hand pair) in high-affected (blue bars) and low-affected (red bars) contexts. Raw judgments are shown as (jittered) dots. Means and 95%

credible (highest-density) intervals are shown as black bars and white panels respectively

Inspection of this figure suggests that

- As per our first preregistered prediction, participants gave higher acceptability ratings to identical **passive** sentences (e.g., *Jack was seen by Emily*) in high-affected contexts (e.g., *Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back. Then…*) than low-affected contexts (e.g., *Jack was looking for his friend Emily in the park. Then…*).
- As per our second preregistered prediction, participants gave higher acceptability ratings to identical **active** sentences (e.g., *Emily saw Jack*) in high-affected contexts (e.g., *Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back. Then…*) than low-affected contexts (e.g., *Jack was looking for his friend Emily in the park. Then…*).
- As per our third preregistered prediction, participants' preference for identical sentences in high- over low-affected contexts was **greater for passive than active sentences**, though only to an extent of around 2 points on the 100-point scale.

To confirm this pattern statistically, we analyzed the data using our preregistered syntax at https://osf.io/4cdga/, with no deviations necessary. All analyses were conducted in the R environment (R Core Team, 2022). Mixed effects models built with the lme4 package (Bates, Mächler, Bolker, and Walker, 2015) would not converge with certain random effects structures that we wished to evaluate. We therefore adopted the contingency plan set out in our preregistration syntax: using the JuliaCall package (Li, 2019) to call the JuliaStats Mixed Models package (Bates, Alday, Kleinschmidt, Calderòn, Noack, Kelman et al, 2021). This allowed us to build models with all possible random effects structures, and select for reporting the models with the lowest BIC (Bayes Information Criterion) value (again, as per our preregistration).

The use of the JuliaStats Mixed Models package necessitated the approximation-via-the-*z*-distribution method of obtaining *p* values (rather than the using Satterthwaite or Kenward-Roger approximation), but this is satisfactory – and probably even optimal – for models with a large sample size (see the linked comment from Phillip Alday, one of the Mixed Models developers: https://github.com/palday/JellyMe4.jl/issues/54#issuecomment-918241307).

Following the tutorial set out in Schad, Vasishth, Hohenstein and Kliegl (2020), we used sum contrasts for both Sentence Type (Active = -0.5, Passive = +0.5) and Context Type (i.e., affectedness Low = -0.5, High = +0.5) and estimated within-sentence-type effects of context directly within the model, rather than by running separate subgroup analyses. That is, Predictions 1 and 2 were tested using the following model (the random-effects-structure variant with the lowest BIC value):

- Response ~ SentenceType/ContextType +
  (1+SentenceType+ContextType|Verb) +
  (1+SentenceType+ContextType|Participant)

Note the use of the slash operator ("/"), which yields estimates of the effect of Context Type (High vs Low affectedness) separately within each level of Sentence Type (Passive and Active). Prediction 3 was testing using an equivalent model with the more familiar "*" operator, which yields an estimate of the interaction:

- Response ~ SentenceType*ContextType +
  (1+SentenceType+ContextType|Verb) +
  (1+SentenceType+ContextType|Participant)

Importantly, at a global level, these two models are identical (indeed, they have the same BIC value and yield the same estimates of the main effects); they differ only in the way that they carve up the variance associated with the interaction.

The first model (testing Predictions 1 and 2) is shown in Table 11. As per our preregistered predictions, both (1) passive and (2) active sentences were rated as significantly more acceptable in high- than low-affectedness contexts (p=0.001 and

p=0.03 respectively). Our use of sum coding and unstandardized coefficients means that the coefficient values in Table 11 can be interpreted straightforwardly: Passive sentences were rated as more acceptable in high- than low-affectedness contexts to the tune of 5.70 points on the 100-point scale (*SE*=1.73). Active sentences were rated as more acceptable in high- than low-affectedness contexts to the tune of 3.83 points on the 100-point scale (*SE*=1.73). Clearly, then, these effects – while statistically significant – are relatively small in absolute terms. (Incidentally, passive sentences were rated as significantly less acceptable than active sentences ($p<0.0001$) to the tune of 14 points on the 100-point scale; *SE*=2.11)

Table 11. Participants significantly prefer high-affected over low-affected contexts for both passive sentences (final row) and active sentences (penultimate row)

	Coef.	Std. Error	z	Pr(>z)
(Intercept)	71.77	2.13807	33.57	<1e-99
SentenceType: Passive	-14.0136	2.11793	-6.62	<1e-10
SentenceType: Active & ContextType: LowAffected	-3.83	1.73062	-2.21	0.0269
SentenceType: Passive & ContextType: LowAffected	-5.70055	1.7306	-3.29	0.0010

The second model (testing Predictions 3) is shown in Table 12.

Table 12. Participants' preference for sentences in high- over low-affected contexts is greater for passive than active sentences (final row)

	Coef.	Std. Error	z	Pr(>z)
(Intercept)	71.77	2.13884	33.56	<1e-99
SentenceType: Passive	-14.0136	2.11767	-6.62	<1e-10
ContextType: LowAffected	-3.83	1.73122	-2.21	0.0269
SentenceType: Passive & ContextType: LowAffected	-1.87055	0.858855	-2.18	0.0294

As per our preregistered prediction, a significant interaction was observed (p=0.03), indicating that participants' preference for identical sentences in high- over low-affectedness contexts was greater for passive than active sentences. Again, this coefficient can be interpreted straightforwardly: Participants' preference for high-versus-low affectedness contexts for passives (5.70 points) is greater than participants' preference for high-versus-low affectedness contexts for actives (3.83 points) to the tune of 1.87 points on the 100-point scale. Again, then, this effect – while statistically significant – is clearly relatively small in absolute terms.

In summary, although the observed effects were numerically small; all three of our preregistered predictions were supported: For both (1) passive and (2) active sentences, participants gave significantly higher acceptability ratings to identical sentences in high- than low-affectedness contexts, though, crucially, (3) this effect was significantly greater for passive sentences; a pattern predicted on the basis that the passive construction – even more so than the active construction – is associated with the semantic property of affectedness.

3.0 Discussion

The aim of the present work was to propose and test a revised theory of Construction Grammar (a functionalist, constructivist approach), under which the grammatical acceptability of a particular sentence (e.g., *Jack was seen by Emily*) is determined not by the semantic compatibility between the construction frame ([A] was AFFECTED by [B]) and the verb (e.g., *see*) but by the semantic compatibility between the construction frame and the particular *event* that the verb describes in context (e.g., a particular *seeing* event). In support of this proposal, we found (consistent with our preregistered predictions) that *the same sentence* (e.g., *Jack was seen by Emily*) is rated as more acceptable when [A] (e.g., *Jack*) is highly affected (e.g., "Jack was trying very hard to avoid Emily, because he owed her a huge amount of money he couldn't pay back") than in a more neutral scenario ("Jack was looking for his friend Emily in the park"). Although a similar effect was observed for active sentences – which was expected on the basis that the SVO-transitive construction also has the semantics of *affectedness* – the effect was larger for passives. This makes it very difficult to argue

that the affectedness effect observed for passives was due to some general property of the high- vs low-affectedness contexts (e.g., the "interestingness" or "unusualness" of the scenarios), as opposed to the semantics of the passive construction itself (and, to a lesser degree, of the active construction).

We can see four implications of the present finding. The first is that functionalist/constructivist accounts are broadly correct in positing that constructions have meanings in and of themselves; although, as we will argue shortly, they will need modifying to account for the present findings. The second is that formalist/lexicalist accounts are incorrect to assume (as Müller, 2020: 587 puts it) that "syntactic structure…is determined by lexical information", as opposed to at the construction level. Of course, it would be possible for formalist/lexicalist accounts to maintain that the context effects observed in the present study are not located in "the grammar" but in some other part of the language system, such as in pragmatics or discourse. However, this approach seems to us to lack parsimony because the same functionalist/constructivist semantics-based account can explain not only why certain passive sentences are preferred in some contexts over others, but also why other passive sentences are ruled out altogether (e.g., $5 was cost by the book; see Ambridge et al, 2016). That is, both are explained by a continuum of affectedness (the meaning of the passive construction). Increasing affectedness by means of a context manipulation increases the acceptability of (for example) *Jack was seen by Emily*. But decreasing affectedness by manipulating the verb (e.g., $5 was cost by the book) rules out the sentence altogether. By comparison it seems un-parsimonious to posit, as the formalist/lexicalist approach must, one mechanism that rules out *$5 was cost by the book* as a possible sentence (e.g., the passive is not listed in the verb's lexical entry), and quite another – discourse pragmatics – that explains the fluid acceptability of *John was seen by Emily*.

This leads us into the third implication of the present findings: that context is not an "add-on" to be considered after syntactic and semantic considerations, but rather that *verb meaning in context* in and of itself partly determines syntactic structure. In the real world, as opposed to in linguistic investigations, no sentence exists independent of its context; where context means not only the preceding linguistic material, but also real-world context, including the listener's understanding of the

speaker's communicative goals, at both the narrow level (i.e., relating to this sentence) and the broader level (i.e., to the entire conversation, anecdote etc.).

It is important to acknowledge that, while statistically significant, the context effects observed in the present study were small; around 5 points on a 100-point scale. However, this is to some extent a reflection of the particular sentences chosen. All of the passive sentences in the present study were "grammatically acceptable" in a binary sense. Thus, the only possible role for a highly-affected context was to increase somewhat the acceptability of a sentence that is already generally acceptable. Presumably much bigger effects would be seen if we were to use context to ameliorate the acceptability of otherwise-broadly-unacceptable sentences. This prediction should be tested in future studies. In the meantime, it bears repeating that the very same semantic constraint which yielded small contexts effects in the present study (i.e., *affectedness*) indeed yields much larger differences between grammatical and ungrammatical passives, when this is manipulated directly; in some cases, a difference of close to the maximum possible, i.e., 4 points on a 1-5 acceptability scale (Ambridge et al, 2016).

Future studies should investigate whether these effects generalize to other languages and to other constructions. In connection to the first possibility, as noted in the Introduction, similar semantic effects for the passive have already been observed for Indonesian, Mandarin and Balinese (Aryawibawa & Ambridge, 2018; Liu & Ambridge, 2021; Darmasetiyawan & Ambridge, 2022) languages into which the present study could be translated more or less in its entirety.

For now, the present study has shown – to our knowledge for the first time – that the grammatical acceptability of a particular sentence (e.g., *Jack was seen by Emily*) is determined not by the semantic compatibility between the construction frame ([A] was AFFECTED by [B]) and the verb (e.g., *see*) *per se* but by the semantic compatibility between the construction frame and the particular *event* that the verb describes in context (e.g., a particular *seeing* event). Future studies, whether they adopt the functionalist/constructivist framework that we advocate here or seek to situate them in the discourse-pragmatics elements of more formalist/lexicalist approaches, will need to be able to account for these findings.

Chapter 6: Discussion

Chapter 1 outlined competing accounts of the representation of syntax according to generativist and constructivist approaches through describing for each both general principles and some specific accounts. The introduction ended with the emphasis that generativist accounts see adult representations in terms of rules that can operate where meaning is not necessarily relevant, and may even have some innate basis, while constructivist accounts place the role of this meaning at the centre.

Chapter 2 outlined competing accounts of the passive under various generativist and constructivist accounts, studies of passive in both children and adults, and in particular studies that investigated the role of semantics in passive representations for both children and adults. Although generativist and constructivist accounts and studies contributed support for the view of abstract syntactic role and meaning-based representations, respectively, it was a clear limitation that most of the studies were conducted solely with children and in English.

Chapter 3 then explored the possibility of a semantic representation of the passive, and its implications for claims of the generativist account, by replicating a previous adult study (Messenger, Branigan, McLean, & Sorace, 2012) with a sufficiently powered sample size. Strong evidence of syntactic priming was found in this replication compared to only weak evidence of semantics. This finding, however, does suggest that semantics may play, for adults, at least a minor role, and also quite dramatic variation of the size of this effect according to the paradigm used to access it.

Chapter 4 then tested the semantic affectedness account of the passive in another language, Balinese. It was clear that an effect of verb semantics was found through a grammaticality judgment study with adults. The apparent discrepancies between the findings of Chapter 3 (weak-to-no semantic effect) and Chapter 4 (large semantic effect) for adult representations were addressed using a context-study in Chapter 5. This study explored the contribution of context to semantic effects in, again, adult grammatical acceptability ratings. The findings suggested that context is a significant discourse-pragmatics factor that should be incorporated and considered when testing for semantic effects; but also, that the two are linked rather than separate.

Context effects work by setting up a context in which the semantic affectedness constraint on the passive is most easily satisfied.

In this final chapter, further theoretical implication will be discussed, and future studies will be suggested for each of the current studies conducted. This chapter will conclude by summarizing the overall contribution of this thesis with regard to accounts of adults' linguistic representations (and, more indirectly, child language acquisition studies).

1.0 Study 1: English adult passive representation

Recent evidence in regard to adult passive representations yields contradictory evidence for both the generativist claim of pure-syntax approach (in particular Branigan & Pickering, 2017) and constructivist claim of a semantics-based approach (in particular Ambridge, Bidgood, Pine, Rowland, & Freudenthal, 2016). One study by Messenger, Branigan, McLean, & Sorace (2012) tested this apparent contradiction using a priming study and found that syntactic representation in adults seem impervious to semantics. That is, adults prime passives just as well when they do not fit the putative semantic prototype. Based on the calculation that Messenger et al's (2012) study may well have been underpowered, their Study 2 was replicated using an online methodology sufficiently powered to detect the crucial interaction of verb-type by sentence type, which investigates whether – as predicted by the semantic prototype account – semantic priming effects are bigger for theme-experiencer verbs that fit the passive semantic prototype (e.g., *frighten*) than experiencer-theme verbs which do not (e.g., *see*). With a Bayes factor result of 1.51 and p=0.023 for the prime-type by verb-type interaction, the present study showed only very weak evidence of semantics and, in fact, stronger evidence for the role of "pure-syntax" (in that a large effect of passive priming, regardless of verb type) was observed. However, it is important to note that this finding cannot be taken as evidence for a null or zero effect of semantics (i.e., the evidence is stronger for semantics than against it). That is, we cannot conclude that "the magnitude of priming was unaffected by verb type" (Messenger et al, 2012: 568) or that "syntactic representations do not contain semantic information" (Branigan & Pickering, 2017: 8). This first study established the need for a better model of adult

representations that can accommodate both fully-abstract syntactic information and semantic/lexical information.

1.1 Theoretical and practical implication

One of the most important implications to follow from this study is how far modifications to the experimental method seemingly affected the findings. Although the underpowered sample size is clearly a factor in the differing findings of the original and replication study, other factors may contribute towards the differences in findings (e.g., the use of animations instead of still pictures). This difference can also be seen clearly through the different effect observed for a similar study (Bidgood, Pine, Rowland, & Ambridge, 2020) that – while otherwise similar to Messenger et al and the present study used animations to reduce any difficulties of illustrating the verb; particularly the experiencer-theme verbs (e.g., *a mouse was seen by a pirate*). This change was important as it meant that, unlike in the original study, difficulties with experiencer-theme passives could not be dismissed as merely reflecting general problems with experiencer-theme verbs. Indeed, Bigdood et al found (unlike the present study) strong evidence for the interaction: the semantic affectedness effect was bigger for passives than actives. Similarly, the same method of animations was used in a replication in Indonesian (Aryawibawa & Ambridge, 2018) and Balinese (Darmasetiyawan & Ambridge, 2022; the present Chapter 4), and also produced evidence in support of significant semantic effect. Nevertheless, the crucial effect of visual changes to the stimuli does not necessarily imply that all previous findings were unreliable; in fact, some of the previous findings using pictures (e.g., Bidgood et al, 2020) were largely supported by the present findings, which also used this method, such as an overall effect of passive priming.

In a previous priming experiment, similar in many ways to the present study, it was found that passives are more likely to be produced when the target picture contained an animate patient versus an inanimate patient (i.e., Gámez & Vasilyeva, 2016). Although the present study did not manipulate animacy, our findings of a (modest) semantic effect are consistent in the sense that an inanimate patient is more likely to be affected (i.e., agent-patient or theme-experiencer verb) and cannot really

appear with an experiencer-theme verb, which is the worst fit for the passive. Although previous studies have found that thematic role mappings can be primed independent of syntactic structure, lexical content, and animacy (Branigan & Pickering, 2018), this priming does not seem to extend from destination to recipients (or vice versa), which suggests that these two roles are distinct (Ziegler & Snedeker, 2018: 235). Ziegler and Snedeker's findings are consistent with a semantic representation of the passive, where thematic structure and animacy can put constraints on argument realization, which in this instance is the role of agent and patient in the passive. That said, it is important to note that while Ziegler and Snedeker's (2018) findings are consistent with a probabilistic semantic-constraint approach to the passive, such as we argue for here, they are also consistent with formal-semantics approaches that distinguish between – as did the participants in their study – destinations and recipients (e.g., Saeed, 2015).

In terms of methodological considerations, although a time limit and check trials were added into the experimental procedure of this study, it is important to note that the experimental replication was altered to use an online method to comply with the global pandemic restrictions that prohibited face-to-face meetings. Consequently, while the main objective of the pre-registered sample size (arrived through a power calculation) was achieved (*N=240*), the large number of excluded participants that did not qualify for inclusion can also imply a risk in "quality control". 50 out of an original total of 290 participants (excluding technical failure responses) that were gathered using this online experimental method were excluded due to the failure to pass check trials. This would be a low exclusion rate for children, but is much higher than face-to-face studies with adults, where the drop out rate is usually close to zero. Despite the attention controls put into the trials (as well as additional screening from Prolific), some of these failures were even due to obvious participant characteristic, such as being under the influence of alcohol or simultaneously doing another activity (e.g., sleeping, or calling someone on the telephone). This large number of excluded responses may also imply that the combination of using still picture and the absence of experimenter might contribute to the higher drop-out rate and more difficulties encountered by participants during the experiment.

Lastly, through the comparison of these adult findings to similar studies with children (e.g., Messenger et al, 2012), it is clear that abstract syntactic representations

appear to grow and strengthen with the speakers' cognitive development; in the sense that semantic effects observed in adults' representation studies was indeed found to be 'small' – smaller to the ones observed in studies of children's representations (e.g., Bidgood et al, 2020). Therefore, the focus in adult representation studies should be on the presence of semantic effects, rather than its measurement – i.e., the size of this effect – since in adults, the growth of abstract syntactic representation would mean that these item-by-item lexical semantic effects are reduced, even on the assumption that the abstract representations were formed by language learning and exposure to passives in the linguistic environment. A final theoretical implication of this study is that, in support of Ambridge (2020b), semantic effects are driven by mid-level representations, rather than highly abstract ones (e.g., those at the level of syntactic phrases and categories) or concrete ones (e.g., individual stored passive utterances). Different levels of priming for passives with different classes of verbs (e.g., agent-patient, theme-experiencer, and experiencer-theme) suggests that rather than very high level grammatical abstractions (e.g., phrases, heads, or complements), adult passive representations are (approximately) more at the level of [AGENT], [VERB], [RECIPIENT], or [THEME].

1.2 Future studies

Since we have found that a slight modification of the priming study methodology (i.e., comparing Messenger et al, 2016 and Darmasetiyawan et al, 2022 with Ambridge et al, 2016 and Bidgood et al, 2020) can significantly affect the findings and their implications for accounts of language representation, it is important for future studies to establish a more reliable approach that will be able to sufficiently detect both abstract-syntactic and semantic effects (since both were observed here). On the theoretical level too, it is important for theoretical accounts to explain both types of effect, which would help to reconcile the differences of view between generativist and constructivist approaches (which emphasize abstract, syntactic-based and lexical/piecemeal semantics-based knowledge respectively). One possibility of such approach is exemplar-based approach (see Ambridge, 2020a, 2020b for a review and summary) that sought to accommodate both views in terms of multiple level of

representations along with the non-linguistics factors that can affect language (i.e., attention or interference).

This approach is also compatible with recent development in language acquisition research based around computational models. For example, Johns, Jamieson, Crump, Jones, & Mewhort (2020) present an exemplar-based memory model (i.e., BEAGLE or MINERVA), that can predict grammatical judgment accuracy, completion, and variation in categorical characteristics. The established IPM (Instance Production Model) can even yield effects that have been observed in human studies of syntactic priming and generate the correct target word order for novel sentences. For example, out of over 479 million possible word-orderings for a 12-word sentence, the model not only typically prefers that preferred by human speakers in general, but also – in the case of alternations – the variant typically produced following a particular manipulation, such as in syntactic priming studies. For example, in the priming of *the brick struck the car's windshield* (active) and *the car's windshield was struck by a brick* (passive), the model's choice varies according to the structure of the prime sentence. Just as for adults, this is the case when there is no prime-target overlap in function words (i.e., *was* or *by*), and in the case of the model, when they are omitted altogether.

Modelling is useful because it allows us to test theories in way that is not possible when they exist solely as verbal accounts. Consider, for example, the question of whether an exemplar-based model can generate novel passives solely on analogy to existing stored passives, or whether some highly abstract (and possibly innate) syntactic rule is acquired. Without modelling, the debate cannot progress far beyond mere assertions on either side. But by building a computational model of passive production (or of a particular task involving, for example, passive priming), we can investigate whether it is possible, in principle, to simulate adult priming effects given exemplars-based generalization only, or whether some hard-wired abstract rule is required.

In conclusion, although much work needs to be done to arrive at fully implemented computational versions, exemplar models hold the promise of potentially being able to explain both the abstract syntactic effects and (more weakly) semantic effects observed in the present Study 1.

2.0 Study 2: Balinese adult passive representation

Following the ongoing debate in the literature between pure-syntax and semantics-based approaches to adult passive representations, a previous study that found a passive-semantics effect in English (Ambridge, Bidgood, Pine, Rowland, & Freudenthal, 2016) was tested cross-linguistically in Indonesian (Aryawibawa & Ambridge, 2018) and Mandarin (Liu & Ambridge, 2021), with similar findings. To further test the cross-linguistic applicability of these findings, Balinese – which has four different passives (which resulted in a total of 245 sentence types) – was investigated. A grammaticality judgment study with 60 participants found that significant semantic affectedness effects were observed for the acceptability of *-a*, *ka-*, and *ma-* passives; but not for non-canonical (basic) passives. This finding can be taken as support for the language-specific claim that the so-called "basic passive" in Balinese may not actually be considered a "true" passive (Arka, 2003; Artawa, 2013), but instead simply has passive characteristics (Udayana, 2013). It also clarifies the Balinese literature on the role of volitional (*-a* > *ka-*) passives, as well as agent role (basic > *ma-* passive). More importantly, the support for a semantics-based account of speakers' syntactic representation obtained in this study highlights further factors beyond "pure-syntax" that must be accounted for in any theory of the representation of adult passives.

2.1 Theoretical and methodological implications

As well as being the first study of Balinese passives, this study is – to our knowledge – the first adult psycholinguistic study of any kind to be conducted in this language (or its close family). Balinese is generally considered to be in the same group as Sasaknese and Sumbawanese; all languages that are closely related (phonologically) to Malay, in the wider family of Austronesian languages (Adelaar, 2015). Within this wider language group, Balinese itself can be considered a niche language, due to its role as regional language in Bali: The majority of the speakers use Balinese only when in Bali,

rarely when living outside of Bali, and are also first-language speakers of Indonesian. The importance of studying Balinese is that, as a typical member of its narrow language family (along with Sasaknese and Sumbawanese) it is likely that the observed findings might generalise to other languages in the group. Interestingly, even in a language with relatively small number of speakers when compared to English (Ambridge et al, 2016) or Indonesian (Aryawibawa & Ambridge, 2018), semantic effects can still be observed to a similar degree.

In terms of language acquisition, it is important to note that most Balinese speakers (excluding speakers who live far from large population centres, for example in mountains and remote villages) are considered to be bilinguals or even multilingual speakers. They are bilinguals to the extent that they also have to master Indonesian as their national language, and most are also regarded as multilingual speakers due to the need for foreign languages proficiency (i.e., English or Chinese) to meet the demand of tourism. This is important from a methodological standpoint, because researchers often decide to study only monolingual speakers, and are concerned about transfer effects from other languages; particularly in cases such as Balinese, where another language – in this case Indonesian – is more dominant in day-to-day life. The findings of the present study (and related study in Indonesian; Aryawibawa & Ambridge, 2018) suggest that – at least for these types of studies – such concerns are unfounded; participants are perfectly capable of giving meaningful judgments in (one of their) first language(s), and their judgments are not contaminated by the other, dominant language. The methodological implication is that researchers should not be reluctant to study bilingual or even multilingual speakers, particularly as this may mean findings are very atypical (since in many parts of the world such as Indonesia, bilingualism is the norm). This also has theoretical implication in that semantic effects on adults' passive representation can be observed – and so must be accounted for – amongst bilingual or even multilingual speakers.

2.2 Future studies

Due to the vast number of languages spoken in Indonesia, and the Austronesian region more generally, future similar studies could be run in similar languages including, for

example, Sasaknese (which belongs to the same language group as Balinese), and Javanese as an example of a language that does not belong to the same language group. If the semantic constraints observed in the present study really are universal, then they should apply in different unrelated languages.

Following the present study on multilingual speakers, future work investigating the nature of adults' syntactic representations can be expanded to investigations of second language acquisition. In the case of the majority of Balinese speakers, while Balinese – and often Indonesian – can be considered as first language (spoken and used by parents in family environment right from birth), English is very much a second language (even given the huge influence of tourism in Bali). While it is a compulsory subject at school, English can still be considered as a second language, since it is generally not spoken, introduced or taught by parents at home.

Interestingly, a previous study with multilingual speakers (Hartsuiker, Beerts, Loncke, Desmet, & Bernolet, 2016) – an active/passive syntactic priming study similar to the present Study 1, found evidence that priming between languages (for multilingual speakers) is similar, including in the size of the effect, to priming within a language. However, another more recent study with bilingual speakers (Ahn, Ferreira, & Gollan, 2021) found that sentence production of bilinguals differs depending on the language that they are actively speaking, suggesting that representations were separated and that language-specific activation of sentence structures were observed. The difference may be due to the fact that, in this study, the sentences share a very different linear word order (whereas in Hartsuiker et al, 2016; the languages used share identical word order for the sentences in question). In this instance, the former study provided evidence of the same priming effect from first and second language as well as between two second languages (Hartsuiker et al, 2016: 29). In contrast, the latter (Ahn et al, 2021) suggested that even when bilinguals frequently switch between languages, they still did not show sentence production patterns that suggest dual-language activation. That is, language-specific activation seemed to persist even with recent use (i.e., language switching) of another language. Although both studies seem to support the view of (at least partly) shared syntactic representation across languages, it is important to note that speakers of different language groups (i.e., bilingual versus multilingual learners of the same languages) experience different

exposures to the languages. Future studies should attempt to investigate the difference of this syntax activation and representation between bilinguals and multilingual group of speakers.

In the meantime, a recent study by Grüter & Hopp (2021) found that German-English bilinguals showed bigger effects of the *timing* of linguistic input than of their current language use. In other words, their findings constitute evidence that the early-learned language (first language/L1) exerts more influence on sentence processing than the current language (second language/L2), even though the latter is the one that is currently spoken the most. Although Grüter & Hopp's (2021) study did not directly address the issue of age of acquisition (i.e., critical period) versus usage-related factors, it did provide evidence that the timing of linguistic input matters, in that it led to asymmetric crosslinguistic influence in the development of late bilingual sentence processing. The findings of this study can suggest that Indonesian-English or Balinese-English bilinguals (not Balinese-Indonesian bilinguals, since both languages are L1) might also be expected to show similar crosslinguistic influence when processing the passive construction; an interesting question for future study.

In conclusion, the present Study 2 has shown that semantic affectedness effects on the acceptability of passive sentences – first observed for English and later for Mandarin and Indonesian – also extend to Balinese, a minority language that is generally learned alongside another (Indonesian). These findings suggest that, while not all languages have a passive construction, for languages that do, the idea of semantic affectedness (e.g., X was frightened > seen by Y) may approach the status of a semantic universal.

3.0 Study 3: Context in English adult passive representation

Although Study 1 found only a weak semantic-affectedness effect, findings from several other studies of English (Bidgood, Pine, Rowland, & Ambridge, 2020; Ambridge, Bidgood, & Thomas, 2021; Jones, Dooley, & Ambridge, 2021) along with the Balinese findings of Study 2 support the constructivist prediction of a verb-semantics effect. In order to further test this possibility, this study manipulated the semantics of scenario/context, while holding the verb constant. This contrasts with

previous studies, where semantic compatibility between the verb and the passive construction (i.e., semantic affectedness) was manipulated through changing the verb). Using a 100-point rating scale of grammatical acceptability, 100 adults rated passive sentences presented in high-affectedness and low-affectedness contexts with 24 experiencer-theme verbs (chosen to avoid ceiling effects, since verbs of this type generally receive the lowest acceptability ratings in the passive in English, and also in other languages, including in Balinese in Study 2). As predicted, the dispreference for passives as compared to actives was larger in the low-affectedness context (5.70 points difference on the 100-point scale) than the high-affectedness context (3.83 points difference); thus, the difference between these differences was 1.87 points on the 100-point scale. As these numbers show, the size of this effect was relatively small. Nevertheless, the context effect was comfortably statistically significant, suggesting that the small (absolute) effect probably reflects the use of only grammatically acceptable sentences in the experiment (thus, leaving room only a small effect from the context manipulation to appear; with most sentences receiving close-to-ceiling acceptability ratings, even in the low-affectedness context). This finding also suggests that context is not merely an add-on to the sentence, to be taken account of following syntactic and semantic considerations (i.e., relegated to non-syntactic factors like pragmatics or discourse). Instead, verb meaning *in context* in and of itself partly determines syntactic structure.

3.1 Theoretical and methodological implication

One important implication of the present study is that – although little attention is often paid to them in psycholinguistic experiments – nonlinguistic factors can affect language representations. Although the context was presented in terms of sentences, this was purely for convenience, since it would be very difficult to create pictures or animations that set up the relevant context. But, in principle, the claim is that the results would be the same. The context is "nonlinguistic" in the sense that it does not *rely* on language being used to set the context, even though that was done here. While the topic of context in pragmatics and discourse analysis has been a vast topic studied in its own

right (i.e., Leech, 1983; Halliday and Hasan, 1976), the role of context is rarely considered in studies, theories and models of language representation.

A methodological implication is that due to the significant effect that scenario (context) can have on the acceptability of passives, as seen in these Study 3 findings, priming studies should take account of contextual considerations when generating stimuli, and when having participants describe them in the experiment. This is particularly true for the passive, which is natural when it places the focus on a topic that is already under discussion. This is not the case for most (perhaps any) passive priming studies (at least of which we are aware), and the findings of the present study suggest that context must be taken into consideration. The findings suggest that context is not just an effect that influence the results, but rather plays a crucial role in the formation of adults' linguistic representation.

Given the use of grammaticality judgments in this study (and study 2), it is important to raise the issue of how methodologically, grammaticality judgments versus priming studies reveal underlying language representations. A useful perspective here is offered by Ambridge (2017: 285) in a commentary on a Branigan and Pickering (2017) target article arguing for the superiority of syntactic priming as a more direct method of tapping into linguistic representations:

> …sometimes, an acceptability judgment paradigm is the best choice; for example when we want to know which of two similar forms is more consistent with adult speakers' underlying grammatical representations (e.g., **The funny clown giggled Bart* vs **The funny clown laughed Bart*). This can really only be determined using a Likert-scale type judgment. Structural priming is all but useless here, because no adult native speaker of English is going to produce either sentence, no matter how much you prime her. The broader problem is that structural priming yields a binary outcome measure: you're primed or you're not; you produce the sentence or you don't. In contrast, acceptability judgments, if set up to do so, yield a continuous outcome measure. Crucially, the use of a relatively insensitive binary measure over a much more sensitive continuous measure can lead to erroneous conclusions regarding representation.

Indeed, it is clear from the present study 1 that priming would require more participants to yield a significant sentence type by verb type interaction for observing semantic effects of passive representation, as compared to grammaticality judgments in study 2 and 3.

Thinking more broadly about the role non-linguistic (contextual) factors in the study of language representation, the central debate between formalist and constructivist approaches can also be viewed as part of a larger debate between purely "linguistic" and "cognitive" views of language.

One study by Sutton (2004) attempted to provide a convergence between the opposing views of distributed cognition and integrational linguistics. While distributed cognition would argue that context involves mind projection to cognitive objects (external resources) in cognitive states (biological and non-biological state), integrational linguistics sees it as contextualizing; where there is no abstract, permanent set of meanings and messages in either language or thought, prior to episodes of thinking and communicating (Sutton, 2004: 507). It is important to note that the view in linguistics is one that suggests we should not seek to categorize an abstract and general 'language system', but instead investigate the complex and diverse practice that drives changes in 'contextualizing'. For example, distributed cognition viewed an activity of writing as intelligent activity driving the process that can include a notebook, a sketchpad, old notes in scraps of paper, and so on (external resources are assimilated, parasitised, or internalised). This view would also extend to the transfer of language that was rejected by Integrational linguistics – in short, they argued that language is not just transfer or expression, it is also transforming. Integrational linguistics viewed the nature of such activity from the properties of talk and silence in prosody, gesture, and facial expression that can combine an integrational point of view into a rich picture of the development of utterance. Both views do, however, shares a few key concepts that context includes social, environmental, bodily, and neural factors. The internal states of both views are primarily action-oriented, set up for the integration of goals or processes, while the external symbols from both views are not regarded as mere supports, but play key roles by transforming the tasks or the requirements of the situation. In summary, Sutton (2004) argued that

> Context-dependence is itself a matter of degree. The extent to which meanings shift with contextual change is itself not constant across contexts: so our understanding of cases in which there is some degree of stability across

> contexts requires a framework in which the very idea of semantic stability across contexts makes sense (Sutton, 2004: 519).

Indeed, one study of word learning by Hollis (2020) suggested that the competing factors of contextual diversity versus word frequency, when seeking to explain why some words are learned before others, are subject to the nature of the internal and external task constraints. For example, lexical-decision-task experiments create large contextual variation, while short-story-reading experiments create less contextual variation, even holding frequency constant. The present Study 3 suggests a useful method for increasing contextual variation – the use of different scenarios varied (in principle) non-linguistically.

3.2 Future studies

The present Study 3 varied the context scenario in terms of affectedness – the event representation was manipulated in such a way that the patient was affected in either deep or shallow, that was either insignificant (e.g., being seen on the park) or significant (e.g., being seen cheating on one's diet). Many other manipulations of context affectedness are possible too. For example, the same sentences may differ in affectedness depending on the roles of the agent and patient e.g., boss and employee, parent and child. For example, in most circumstances, a child/employee is more affected by being "seen" than is a parent or boss, due to the power differential where one sets the rules for another. Because the present study focused on the passive, the context manipulation manipulated the semantics relevant for that construction: affectedness. Similar studies could manipulate the contextual semantics relevant for other constructions (e.g., Pinker, 1989) such as causing-to-have versus causing-to-go for datives or caused-motion versus caused-endstate for locatives.

Methodologically speaking, we would expect to see a potentially larger effect of context in a study based on rating the acceptability of ungrammatical sentences – since grammatical sentences introduce a ceiling effect in acceptability ratings. That is, the present study has shown that context can make an acceptable sentence (slightly)

more acceptable, but can it also make an unacceptable sentence (much) more acceptable.

Theoretically speaking, the present study suggests that context is not merely an add-on to semantic and syntactic accounts, and therefore there is a considerable degree of overlap between what have traditionally been thought of as "semantic" and "context" effects. However, further detailed studies should also be conducted to investigate the interplay between semantics and contexts (e.g., which takes precedence over each other when the two contradict). Such studies can provide particularly important findings when tested crosslinguistically and bilingually, since in different languages and with bilingual versus multilingual speakers, the contextual effects may be different, even for constructions that are similar across languages.

In conclusion, the present study showed that semantic affectedness effects on (English) passive sentence acceptability can be found not just by manipulating the semantic directly (i.e., by changing the verb), but also by manipulating the semantics indirectly (i.e., by changing the context of the sentence, holding the verb – and in fact the whole sentence – constant). This suggests that semantics and context are not separate, and that linguistic representations are built from sentences heard and understood *in context*.

4.0 Overall conclusion

The thesis began with an overall aim to test the formalist/lexicalist/generativist versus functionalist/constructivist debate over adult passive representation that is implied in abstract syntactic and meaning-based representation – where most of the studies are toward children (focused on the early immature stage rather than adults), and in English. Study 1 was conducted to create a foundation to the following studies by replicating an underpowered study (Messenger et al, 2012) to adults and found that while it generally showed syntactic abstract representation, semantic effects were also undoubtedly present. The following Study 2 was attempted in different language (Balinese) and found significantly larger semantic effects, which lead to the assumption that there are other non-linguistic possible factors that affected these

findings. This possibility was then explored further beyond semantic effects in Study 3, and brought forward the significance of context to adult passive representation.

In summary, taken together, the three studies in this thesis were able to provide a significant contribution to the debate on the nature of adults' passive representation: Although it is syntactically abstract, it also showed semantic effects – even in a priming study (Study 1). Significantly larger semantic effects are observed through a different experimental methodology (i.e., grammaticality judgments; Study 2). Crucially, adult passive representation is such that these semantic effects are not restricted just to the words and phrases of the sentence, or even of the whole utterance, but relate to the meaning of the utterance *in context* (Study 3); here affectedness. Of course, the present findings, on their own, will not resolve the generativist versus constructivist debate in language acquisition. At the very least though, in the scope of adult passive representation, they highlight patterns that any successful theory will have to explain, as well as highlighting important areas for future study: different language environments (e.g., study 2), and different language contexts (e.g., study 3).

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List of abbreviations

NP	noun phrase	PF	phonological form
V	verb	LF	logical form
N	noun	GF	grammatical function
D	determiner	CS	conceptual structure
Aux	auxiliary verb	SVO	subject-verb-object
UG	Universal Grammar	SOV	subject-object-verb
DP	determiner phrase	VSO	verb-subject-object
VP	verb phrase	SBCG	Sign-Based Construction Grammar
PP	preposition phrase	ECG	Embodied Construction Grammar
PSG	Phrase Structure Grammar	FCG	Fluid Construction Grammar
TG	Transformational Grammar	SS	Simpler Syntax
GB	Government and Binding	CG	Cognitive Grammar
LFG	Lexical Functional Grammar	CCG	Cognitive Construction Grammar
HPSG	Head-Driven Phrase Structure Grammar	RCG	Radical Construction Grammar
DG	Dependency Grammar	VAL	valence
D-structure	deep structure	SPR	specifier
S-structure	surface structure	COMPS	complements
c-structure	constituent structure		
f-structure	functional structure		

Appendices

Appendix A. Study 1 Output N240 Strict

Family: bernoulli
Links: mu = logit
Formula: RecodeStrict ~ PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb)
Data: Data (Number of observations: 5328)
Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;
total post-warmup draws = 160000

Group-Level Effects:
~Participant (Number of levels: 240)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat
sd(Intercept)	1.85	0.17	1.54	2.21	1.00
sd(PrimeTypeP)	0.89	0.20	0.48	1.28	1.00
sd(VerbTypeTE)	0.44	0.24	0.03	0.93	1.00
sd(PrimeTypeP:VerbTypeTE)	0.58	0.29	0.05	1.13	1.00
cor(Intercept,PrimeTypeP)	-0.21	0.21	-0.57	0.26	1.00
cor(Intercept,VerbTypeTE)	-0.37	0.32	-0.86	0.42	1.00
cor(PrimeTypeP,VerbTypeTE)	-0.00	0.38	-0.76	0.70	1.00
cor(Intercept,PrimeTypeP:VerbTypeTE)	-0.33	0.32	-0.84	0.42	1.00
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	0.23	0.36	-0.51	0.85	1.00
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)	-0.09	0.43	-0.80	0.76	1.00

	Bulk_ESS	Tail_ESS
sd(Intercept)	38876	75837
sd(PrimeTypeP)	17082	23652
sd(VerbTypeTE)	16448	34548
sd(PrimeTypeP:VerbTypeTE)	10675	27387
cor(Intercept,PrimeTypeP)	35475	50943
cor(Intercept,VerbTypeTE)	52548	59872

cor(PrimeTypeP,VerbTypeTE)					30555	61760
cor(Intercept,PrimeTypeP:VerbTypeTE)					59507	58044
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)					42366	70146
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)					22112	49480

~Prime_Verb (Number of levels: 12)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	0.41	0.16	0.14	0.78	1.00	44843	37896
sd(PrimeTypeP)	1.02	0.29	0.60	1.72	1.00	48852	73803
cor(Intercept,PrimeTypeP)	-0.16	0.36	-0.75	0.60	1.00	28703	42690

Population-Level Effects:

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
Intercept	3.24	0.23	2.81	3.69	1.00	61422	93846
PrimeTypeP	-2.23	0.40	-3.00	-1.42	1.00	48429	73015
VerbTypeTE	-0.05	0.12	-0.27	0.18	1.00	165218	126837
PrimeTypeP:VerbTypeTE	-0.47	0.45	-1.34	0.42	1.00	58891	88022

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1).

[1] "posterior"

[1] 0.5545236

[1] "prior"

[1] 1.168326

[1] "BF01, Evidence for the null"

[1] 0.4746311

[1] "BF10 (1/BF01) - Evidence for the hypothesis (Bayes Factor)"

[1] 2.1069

Appendix B. Study 1 Output N240 Lenient

Family: bernoulli

Links: mu = logit

Formula: RecodeLenient ~ PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb)

Data: Data (Number of observations: 5337)

Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;

total post-warmup draws = 160000

Group-Level Effects:

~Participant (Number of levels: 240)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat
sd(Intercept)	1.85	0.17	1.54	2.20	1.00
sd(PrimeTypeP)	0.89	0.21	0.47	1.28	1.00
sd(VerbTypeTE)	0.44	0.24	0.03	0.92	1.00
sd(PrimeTypeP:VerbTypeTE)	0.56	0.28	0.04	1.12	1.00
cor(Intercept,PrimeTypeP)	-0.23	0.21	-0.58	0.24	1.00
cor(Intercept,VerbTypeTE)	-0.38	0.32	-0.86	0.41	1.00
cor(PrimeTypeP,VerbTypeTE)	0.00	0.38	-0.75	0.71	1.00
cor(Intercept,PrimeTypeP:VerbTypeTE)	-0.32	0.32	-0.84	0.43	1.00
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	0.24	0.36	-0.51	0.86	1.00
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)	-0.10	0.43	-0.81	0.76	1.00

	Bulk_ESS	Tail_ESS
sd(Intercept)	40634	79830
sd(PrimeTypeP)	15902	19818

sd(VerbTypeTE)	17718	39071
sd(PrimeTypeP:VerbTypeTE)	11736	28393
cor(Intercept,PrimeTypeP)	38357	51528
cor(Intercept,VerbTypeTE)	62911	67693
cor(PrimeTypeP,VerbTypeTE)	37716	61621
cor(Intercept,PrimeTypeP:VerbTypeTE)	70482	63542
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	49090	78590
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)	24307	58539

~Prime_Verb (Number of levels: 12)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	0.40	0.16	0.13	0.77	1.00	44451	35292
sd(PrimeTypeP)	1.01	0.28	0.59	1.70	1.00	52423	80844
cor(Intercept,PrimeTypeP)	-0.15	0.36	-0.75	0.61	1.00	31010	41102

Population-Level Effects:

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
Intercept	3.24	0.22	2.81	3.69	1.00	68455	101734
PrimeTypeP	-2.24	0.39	-3.01	-1.45	1.00	56781	80043
VerbTypeTE	-0.05	0.12	-0.27	0.18	1.00	186147	127492
PrimeTypeP:VerbTypeTE	-0.47	0.44	-1.33	0.42	1.00	69753	93708

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS

and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1).

[1] "posterior"

[1] 0.5918255

[1] "prior"

[1] 1.185688

[1] "BF01, Evidence for the null"

[1] 0.4991409

[1] "BF10 (1/BF01) - Evidence for the hypothesis (Bayes Factor)"

[1] 2.003442

Appendix C. Study 1 Output N290 Strict

Family: bernoulli

Links: mu = logit

Formula: RecodeStrict ~ PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb)

Data: Data (Number of observations: 6186)

Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;

total post-warmup draws = 160000

Group-Level Effects:

~Participant (Number of levels: 280)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat
sd(Intercept)	2.09	0.18	1.75	2.47	1.00
sd(PrimeTypeP)	0.94	0.20	0.53	1.33	1.00
sd(VerbTypeTE)	0.44	0.25	0.03	0.94	1.00
sd(PrimeTypeP:VerbTypeTE)	0.57	0.28	0.05	1.12	1.00
cor(Intercept,PrimeTypeP)	-0.06	0.22	-0.45	0.40	1.00
cor(Intercept,VerbTypeTE)	-0.35	0.32	-0.85	0.44	1.00
cor(PrimeTypeP,VerbTypeTE)	-0.01	0.38	-0.75	0.69	1.00
cor(Intercept,PrimeTypeP:VerbTypeTE)	-0.27	0.33	-0.82	0.46	1.00
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	0.22	0.36	-0.52	0.85	1.00

cor(VerbTypeTE,PrimeTypeP:VerbTypeTE) -0.09 0.43 -0.81 0.77 1.00

	Bulk_ESS	Tail_ESS
sd(Intercept)	48598	88455
sd(PrimeTypeP)	17909	22692
sd(VerbTypeTE)	19078	45967
sd(PrimeTypeP:VerbTypeTE)	13841	30571
cor(Intercept,PrimeTypeP)	43837	56187
cor(Intercept,VerbTypeTE)	81859	74675
cor(PrimeTypeP,VerbTypeTE)	39923	65097
cor(Intercept,PrimeTypeP:VerbTypeTE)	84285	76769
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	53122	84397
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)	25066	58456

~Prime_Verb (Number of levels: 12)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	0.41	0.16	0.14	0.78	1.00	49304	45356
sd(PrimeTypeP)	1.02	0.28	0.60	1.70	1.00	57896	88198
cor(Intercept,PrimeTypeP)	-0.16	0.36	-0.75	0.60	1.00	34546	50732

Population-Level Effects:

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
Intercept	3.69	0.24	3.23	4.18	1.00	74707	103905
PrimeTypeP	-2.15	0.40	-2.93	-1.35	1.00	66868	86314
VerbTypeTE	-0.05	0.12	-0.27	0.18	1.00	189535	
PrimeTypeP:VerbTypeTE	-0.49	0.45	-1.35	0.42	1.00	78497	

VerbTypeTE 125963

PrimeTypeP:VerbTypeTE 101370

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1).

[1] "posterior"

[1] 0.5430468

[1] "prior"

[1] 1.14521

[1] "BF01, Evidence for the null"

[1] 0.4741898

[1] "BF10 (1/BF01) - Evidence for the hypothesis (Bayes Factor)"

[1] 2.10886

Appendix D. Study 1 Output N290 Lenient

Family: bernoulli

Links: mu = logit

Formula: RecodeLenient ~ PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb)

Data: Data (Number of observations: 6195)

Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;

total post-warmup draws = 160000

Group-Level Effects:

~Participant (Number of levels: 280)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat
sd(Intercept)	2.09	0.18	1.75	2.47	1.00
sd(PrimeTypeP)	0.94	0.20	0.54	1.32	1.00
sd(VerbTypeTE)	0.43	0.25	0.03	0.93	1.00
sd(PrimeTypeP:VerbTypeTE)	0.55	0.28	0.04	1.11	1.00
cor(Intercept,PrimeTypeP)	-0.08	0.22	-0.46	0.38	1.00

cor(Intercept,VerbTypeTE)	-0.35	0.32	-0.85	0.45	1.00
cor(PrimeTypeP,VerbTypeTE)	-0.00	0.38	-0.75	0.70	1.00
cor(Intercept,PrimeTypeP:VerbTypeTE)	-0.26	0.33	-0.81	0.48	1.00
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	0.24	0.36	-0.52	0.85	1.00
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)	-0.10	0.43	-0.81	0.76	1.00

	Bulk_ESS	Tail_ESS
sd(Intercept)	40789	77181
sd(PrimeTypeP)	15946	23508
sd(VerbTypeTE)	16892	39082
sd(PrimeTypeP:VerbTypeTE)	11560	27096
cor(Intercept,PrimeTypeP)	37528	53503
cor(Intercept,VerbTypeTE)	67324	64728
cor(PrimeTypeP,VerbTypeTE)	34424	60772
cor(Intercept,PrimeTypeP:VerbTypeTE)	74277	72465
cor(PrimeTypeP,PrimeTypeP:VerbTypeTE)	46857	77156
cor(VerbTypeTE,PrimeTypeP:VerbTypeTE)	21262	48943

~Prime_Verb (Number of levels: 12)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
sd(Intercept)	0.40	0.16	0.13	0.78	1.00	45054
sd(PrimeTypeP)	1.01	0.28	0.59	1.69	1.00	50077
cor(Intercept,PrimeTypeP)	-0.15	0.36	-0.75	0.61	1.00	28511

	Tail_ESS
sd(Intercept)	37083
sd(PrimeTypeP)	78949
cor(Intercept,PrimeTypeP)	39320

Population-Level Effects:

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
Intercept	3.69	0.24	3.23	4.18	1.00	56506
PrimeTypeP	-2.17	0.40	-2.94	-1.36	1.00	52097
VerbTypeTE	-0.05	0.12	-0.27	0.18	1.00	159308

PrimeTypeP:VerbTypeTE -0.48 0.44 -1.34 0.41 1.00 60681

Tail_ESS

Intercept 90079

PrimeTypeP 75299

VerbTypeTE 122779

PrimeTypeP:VerbTypeTE 89426

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1).

[1] "posterior"

[1] 0.5463109

[1] "prior"

[1] 1.16105

[1] "BF01, Evidence for the null"

[1] 0.4705317

[1] "BF10 (1/BF01) - Evidence for the hypothesis (Bayes Factor)"

[1] 2.125255

Appendix E. Study 1 Frequentist Model

M SE z p_z Model AIC

1 3.565531864 0.2995677 11.90225757 1.151882e-32 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

2 -2.547273680 0.4078675 -6.24534600 4.228630e-10 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

3 -0.477805526 0.3468355 -1.37761412 1.683225e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

4 -0.243602734 0.5460813 -0.44609240 6.555305e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

5 3.542653932 0.2568515 13.79261538 2.823354e-43 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278

6 -2.510371478 0.3778823 -6.64326254 3.068146e-11 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278
7 -0.511714060 0.2629558 -1.94600791 5.165379e-02 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278
8 -0.225755300 0.4971920 -0.45406057 6.497852e-01 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278
9 3.284214576 0.2289114 14.34709891 1.110878e-46 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572
10 -2.309887017 0.3603863 -6.40947454 1.460220e-10 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572
11 -0.111630189 0.2239103 -0.49854866 6.180974e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572
12 -0.567544128 0.4708568 -1.20534340 2.280708e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572
13 3.340075860 0.2158821 15.47175823 5.381683e-54 PrimeType * VerbType + (1 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439
14 -2.321975195 0.3467012 -6.69733846 2.122496e-11 PrimeType * VerbType + (1 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439
15 -0.426648187 0.2490893 -1.71283252 8.674336e-02 PrimeType * VerbType + (1 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439
16 -0.303757557 0.4861492 -0.62482373 5.320868e-01 PrimeType * VerbType + (1 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439
17 3.132871415 0.1945677 16.10170244 2.481809e-58 PrimeType * VerbType + (1 | Participant) + (1 + PrimeType | Prime_Verb) 4227.125
18 -2.175168676 0.3325953 -6.53998622 6.152450e-11 PrimeType * VerbType + (1 | Participant) + (1 + PrimeType | Prime_Verb) 4227.125
19 -0.105432204 0.2214587 -0.47608056 6.340170e-01 PrimeType * VerbType + (1 | Participant) + (1 + PrimeType | Prime_Verb) 4227.125
20 -0.562097975 0.4652852 -1.20807183 2.270196e-01 PrimeType * VerbType + (1 | Participant) + (1 + PrimeType | Prime_Verb) 4227.125
21 2.241986487 0.1296223 17.29630321 5.015583e-67 PrimeType * VerbType + (1 + PrimeType | Prime_Verb) 5145.528

22 -1.531797736 0.2479736 -6.17726057 6.522338e-10 PrimeType * VerbType + (1 + PrimeType | Prime_Verb) 5145.528

23 -0.071477360 0.1811513 -0.39457280 6.931582e-01 PrimeType * VerbType + (1 + PrimeType | Prime_Verb) 5145.528

24 -0.410623211 0.3487072 -1.17755860 2.389726e-01 PrimeType * VerbType + (1 + PrimeType | Prime_Verb) 5145.528

25 3.849377441 0.3713104 10.36700791 3.503224e-25 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

26 -2.910480583 0.2772534 -10.49754651 8.865443e-26 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

27 -0.662551798 0.4524577 -1.46433983 1.431011e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

28 0.005269393 0.3379496 0.01559225 9.875597e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

29 3.686392972 0.3205979 11.49849349 1.342379e-30 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

30 -2.731152576 0.2064700 -13.22784507 6.060002e-40 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

31 -0.540635857 0.3740932 -1.44519039 1.484044e-01 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

32 -0.134779155 0.2179581 -0.61837173 5.363303e-01 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

33 3.454844229 0.2970030 11.63235489 2.822033e-31 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

34 -2.543640627 0.1907947 -13.33182100 1.511623e-40 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

35 -0.174206860 0.3424180 -0.50875497 6.109240e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

36 -0.457002287 0.1844231 -2.47801064 1.321172e-02 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

37 3.376918898 0.2799085 12.06436583 1.629125e-33 PrimeType * VerbType + (1 + VerbType | Participant) + (1 | Prime_Verb) 4274.414

38 -2.429848551 0.1484414 -16.36907233 3.180245e-60 PrimeType * VerbType + (1 + VerbType | Participant) + (1 | Prime_Verb) 4274.414

39 -0.445297277 0.3567698 -1.24813597 2.119813e-01 PrimeType * VerbType + (1 + VerbType | Participant) + (1 | Prime_Verb) 4274.414

40 -0.230358448 0.2014524 -1.14348814 2.528360e-01 PrimeType * VerbType + (1 + VerbType | Participant) + (1 | Prime_Verb) 4274.414

41 3.197651866 0.2615817 12.22429520 2.305728e-34 PrimeType * VerbType + (1 | Participant) + (1 | Prime_Verb) 4277.175

42 -2.296407878 0.1344677 -17.07776117 2.172980e-65 PrimeType * VerbType + (1 | Participant) + (1 | Prime_Verb) 4277.175

43 -0.164029019 0.3326614 -0.49308100 6.219554e-01 PrimeType * VerbType + (1 | Participant) + (1 | Prime_Verb) 4277.175

44 -0.464519408 0.1771888 -2.62160676 8.751635e-03 PrimeType * VerbType + (1 | Participant) + (1 | Prime_Verb) 4277.175

45 2.313534280 0.1752486 13.20144290 8.607045e-40 PrimeType * VerbType + (1 | Prime_Verb) 5178.927

46 -1.630489676 0.1107889 -14.71708899 5.007566e-49 PrimeType * VerbType + (1 | Prime_Verb) 5178.927

47 -0.116516704 0.2459149 -0.47380912 6.356360e-01 PrimeType * VerbType + (1 | Prime_Verb) 5178.927

48 -0.343912044 0.1532828 -2.24364353 2.485535e-02 PrimeType * VerbType + (1 | Prime_Verb) 5178.927

49 3.565526409 0.2995207 11.90410595 1.126643e-32 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453

50 -2.547275177 0.4077806 -6.24668107 4.192659e-10 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453

51 -0.477802607 0.3467835 -1.37781228 1.682613e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453

52 -0.243588714 0.5459472 -0.44617631 6.554699e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453

53 3.542658488 0.2568724 13.79151195 2.866877e-43 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278

54 -2.510390845 0.3779455 -6.64220354 3.090278e-11 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
55 -0.511723382 0.2629850 -1.94582716 5.167551e-02 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
56 -0.225721639 0.4973058 -0.45388898 6.499087e-01 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
57 3.284212143 0.2289264 14.34614836 1.126205e-46 PrimeType * VerbType + (1 + PrimeType | Participant) + (0 + PrimeType | Prime_Verb) 4211.572
58 -2.309879362 0.3603919 -6.40935433 1.461372e-10 PrimeType * VerbType + (1 + PrimeType | Participant) + (0 + PrimeType | Prime_Verb) 4211.572
59 -0.111629005 0.2239188 -0.49852442 6.181145e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (0 + PrimeType | Prime_Verb) 4211.572
60 -0.567553658 0.4708160 -1.20546815 2.280226e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (0 + PrimeType | Prime_Verb) 4211.572
61 3.340073030 0.2159070 15.46996302 5.533883e-54 PrimeType * VerbType + (1 + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4222.439
62 -2.321972052 0.3468029 -6.69536560 2.151331e-11 PrimeType * VerbType + (1 + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4222.439
63 -0.426644790 0.2491265 -1.71256291 8.679298e-02 PrimeType * VerbType + (1 + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4222.439
64 -0.303766051 0.4863280 -0.62461150 5.322261e-01 PrimeType * VerbType + (1 + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4222.439
65 3.132869868 0.1945730 16.10125771 2.499713e-58 PrimeType * VerbType + (1 | Participant) + (0 + PrimeType | Prime_Verb) 4227.125
66 -2.175163620 0.3325814 -6.54024513 6.141808e-11 PrimeType * VerbType + (1 | Participant) + (0 + PrimeType | Prime_Verb) 4227.125
67 -0.105430677 0.2214638 -0.47606278 6.340297e-01 PrimeType * VerbType + (1 | Participant) + (0 + PrimeType | Prime_Verb) 4227.125
68 -0.562108348 0.4652427 -1.20820456 2.269686e-01 PrimeType * VerbType + (1 | Participant) + (0 + PrimeType | Prime_Verb) 4227.125
69 2.241987441 0.1296401 17.29393808 5.225709e-67 PrimeType * VerbType + (0 + PrimeType | Prime_Verb) 5145.528

70 -1.531803616 0.2479662 -6.17746973 6.513706e-10 PrimeType * VerbType + (0 + PrimeType | Prime_Verb) 5145.528

71 -0.071480002 0.1811863 -0.39451104 6.932038e-01 PrimeType * VerbType + (0 + PrimeType | Prime_Verb) 5145.528

72 -0.410611873 0.3487568 -1.17735874 2.390524e-01 PrimeType * VerbType + (0 + PrimeType | Prime_Verb) 5145.528

73 3.565521189 0.2996405 11.89933127 1.192993e-32 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

74 -2.547270983 0.4079587 -6.24394340 4.266744e-10 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

75 -0.477795695 0.3469443 -1.37715397 1.684647e-01 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

76 -0.243595121 0.5462088 -0.44597432 6.556158e-01 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4212.453

77 3.542659932 0.2568911 13.79051471 2.906785e-43 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278

78 -2.510393195 0.3779761 -6.64167246 3.101436e-11 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278

79 -0.511722494 0.2629895 -1.94579033 5.167993e-02 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278

80 -0.225723857 0.4973200 -0.45388054 6.499148e-01 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4206.278

81 3.284216286 0.2289190 14.34662907 1.118428e-46 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572

82 -2.309885956 0.3603862 -6.40947369 1.460228e-10 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572

83 -0.111634376 0.2239080 -0.49857260 6.180805e-01 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572

84 -0.567538685 0.4707869 -1.20551083 2.280062e-01 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + PrimeType | Prime_Verb) 4211.572

85 3.340070556 0.2159009 15.47038861 5.497418e-54 PrimeType * VerbType + (0 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439

86 -2.321965674 0.3467742 -6.69590043 2.143476e-11 PrimeType * VerbType + (0 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439

87 -0.426642860 0.2491216 -1.71258878 8.678822e-02 PrimeType * VerbType + (0 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439

88 -0.303772916 0.4862657 -0.62470558 5.321643e-01 PrimeType * VerbType + (0 + VerbType | Participant) + (1 + PrimeType | Prime_Verb) 4222.439

89 3.849383331 0.3712110 10.36979847 3.402416e-25 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

90 -2.910484685 0.2771893 -10.49999090 8.638846e-26 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

91 -0.662552429 0.4523226 -1.46477843 1.429814e-01 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

92 0.005270811 0.3378687 0.01560017 9.875534e-01 PrimeType * VerbType + (0 + PrimeType * VerbType | Participant) + (1 | Prime_Verb) 4260.159

93 3.686387451 0.3206629 11.49614448 1.379405e-30 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

94 -2.731148344 0.2064962 -13.22614039 6.198983e-40 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

95 -0.540633189 0.3741572 -1.44493581 1.484759e-01 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

96 -0.134780764 0.2179785 -0.61832134 5.363635e-01 PrimeType * VerbType + (0 + PrimeType + VerbType | Participant) + (1 | Prime_Verb) 4256.461

97 3.454839486 0.2969836 11.63309679 2.797606e-31 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

98 -2.543638961 0.1907892 -13.33219364 1.504090e-40 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

99 -0.174203213 0.3423982 -0.50877373 6.109108e-01 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

100 -0.457003968 0.1844211 -2.47804536 1.321043e-02 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 | Prime_Verb) 4259.988

101 3.376916568 0.2798705 12.06599661 1.597171e-33 PrimeType * VerbType + (0 + VerbType | Participant) + (1 | Prime_Verb) 4274.414

102 -2.429846408 0.1484385 -16.36937998 3.164210e-60 PrimeType * VerbType +
(0 + VerbType | Participant) + (1 | Prime_Verb) 4274.414
103 -0.445297124 0.3567146 -1.24832895 2.119106e-01 PrimeType * VerbType +
(0 + VerbType | Participant) + (1 | Prime_Verb) 4274.414
104 -0.230360808 0.2014480 -1.14352481 2.528208e-01 PrimeType * VerbType +
(0 + VerbType | Participant) + (1 | Prime_Verb) 4274.414
105 3.565525389 0.2995147 11.90434034 1.123482e-32 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453
106 -2.547273841 0.4077798 -6.24668989 4.192423e-10 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453
107 -0.477804807 0.3467623 -1.37790279 1.682333e-01 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453
108 -0.243590089 0.5459517 -0.44617520 6.554707e-01 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4212.453
109 3.542661164 0.2568967 13.79021559 2.918863e-43 PrimeType * VerbType +
(0 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
110 -2.510395082 0.3780403 -6.64054924 3.125164e-11PrimeType * VerbType +
(0 + PrimeType
+ VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
111 -0.511721737 0.2630096 -1.94563930 5.169808e-02 PrimeType * VerbType +
(0 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
112 -0.225723364 0.4974829 -0.45373087 6.500225e-01 PrimeType * VerbType +
(0 + PrimeType + VerbType | Participant) + (0 + PrimeType | Prime_Verb) 4206.278
113 3.284214958 0.2289174 14.34672561 1.116873e-46 PrimeType * VerbType +
(0 + PrimeType | Participant) + (0 + PrimeType | Prime_Verb) 4211.572
114 -2.309887178 0.3603450 -6.41021075 1.453186e-10 PrimeType * VerbType +
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115 -0.111631226 0.2239031 -0.49856938 6.180828e-01 PrimeType * VerbType +
(0 + PrimeType | Participant) + (0 + PrimeType | Prime_Verb) 4211.572
116 -0.567541684 0.4707497 -1.20561239 2.279670e-01 PrimeType * VerbType +
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117 3.340068703 0.2158845 15.47155269 5.398896e-54 PrimeType * VerbType +

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118 -2.321974182 0.3467176 -6.69701927 2.127136e-11 PrimeType * VerbType +
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119 -0.426640565 0.2490950 -1.71276246 8.675625e-02 PrimeType * VerbType +
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120 -0.303760240 0.4861785 -0.62479160 5.321078e-01 PrimeType * VerbType +
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121 3.565527817 0.2995003 11.90492137 1.115684e-32 PrimeType * VerbType +
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(1 + PrimeType + VerbType || Participant) + (1 + PrimeType | Prime_Verb)
4210.194
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131 -0.111634215 0.2239058 -0.49857678 6.180776e-01 PrimeType * VerbType +
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132 -0.567542739 0.4707201 -1.20569037 2.279369e-01 PrimeType * VerbType +
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133 3.340075149 0.2158778 15.47206609 5.356005e-54 PrimeType * VerbType +
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134 -2.321974639 0.3467014 -6.69733351 2.122568e-11 PrimeType * VerbType +
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135 -0.426647731 0.2490767 -1.71291674 8.672786e-02 PrimeType * VerbType +
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136 -0.303763055 0.4861277 -0.62486264 5.320612e-01 PrimeType * VerbType +
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137 3.849408005 0.3712800 10.36793932 3.469252e-25 PrimeType * VerbType +
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143 -0.432754644 0.3685263 -1.17428422 2.402812e-01 PrimeType * VerbType +
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144 -0.250677666 0.2076476 -1.20722666 2.273449e-01 PrimeType * VerbType +
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146 -2.543639787 0.1907864 -13.33239649 1.500005e-40 PrimeType * VerbType +
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148 -0.457001881 0.1844167 -2.47809435 1.320862e-02 PrimeType * VerbType +
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149 3.376919393 0.2798637 12.06630058 1.591284e-33 PrimeType * VerbType +
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150 -2.429847800 0.1484318 -16.37012766 3.125576e-60 PrimeType * VerbType +
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151 -0.445296354 0.3566992 -1.24838053 2.118917e-01 PrimeType * VerbType +
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153 3.565525523 0.2994296 11.90772748 1.078774e-32 PrimeType * VerbType +
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4210.194

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161 3.284211688 0.2289061 14.34741708 1.105795e-46 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + PrimeType | Prime_Verb) 4213.572

162 -2.309879583 0.3603018 -6.41095694 1.446090e-10 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + PrimeType | Prime_Verb) 4213.572

163 -0.111629937 0.2238961 -0.49857922 6.180758e-01 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + PrimeType | Prime_Verb) 4213.572

164 -0.567548153 0.4706517 -1.20587710 2.278649e-01 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + PrimeType | Prime_Verb) 4213.572

165 3.340074707 0.2158986 15.47056944 5.481997e-54 PrimeType * VerbType + (1 + VerbType || Participant) + (0 + PrimeType | Prime_Verb) 4224.439

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167 -0.426646728 0.2491091 -1.71269052 8.676949e-02 PrimeType * VerbType + (1 + VerbType || Participant) + (0 + PrimeType | Prime_Verb) 4224.439

168 -0.303761189 0.4862379 -0.62471720 5.321567e-01 PrimeType * VerbType + (1 + VerbType || Participant) + (0 + PrimeType | Prime_Verb) 4224.439

169 3.284216313 0.2289282 14.34605143 1.127780e-46 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType || Prime_Verb) 4213.572

170 -2.309890668 0.3604011 -6.40922237 1.462637e-10 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType || Prime_Verb) 4213.572

171 -0.111634023 0.2239104 -0.49856567 6.180854e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType || Prime_Verb) 4213.572

172 -0.567536948 0.4707876 -1.20550533 2.280083e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + PrimeType || Prime_Verb) 4213.572

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176 -0.303763493 0.4862125 -0.62475454 5.321322e-01 PrimeType * VerbType +
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215 -0.301604977 0.1845810 -1.63399827 1.022592e-01 PrimeType * VerbType + (1 + PrimeType | Participant) + (1 + VerbType || Participant) 4386.318
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234 -2.640255767 0.1953005 -13.51893815 1.209084e-41 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372
235 -0.432754644 0.3685263 -1.17428422 2.402812e-01 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372
236 -0.250677666 0.2076476 -1.20722666 2.273449e-01 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372
237 3.601554309 0.3100078 11.61762644 3.353231e-31 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + VerbType || Participant) + (1 | Prime_Verb) 4261.372
238 -2.640257019 0.1953114 -13.51818908 1.221456e-41 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + VerbType || Participant) + (1 | Prime_Verb) 4261.372
239 -0.432752245 0.3685985 -1.17404780 2.403759e-01 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + VerbType || Participant) + (1 | Prime_Verb) 4261.372
240 -0.250677164 0.2076693 -1.20709770 2.273945e-01 PrimeType * VerbType + (0 + PrimeType | Participant) + (1 + VerbType || Participant) + (1 | Prime_Verb) 4261.372
241 3.601553993 0.3099792 11.61869409 3.311594e-31 PrimeType * VerbType +

(1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372

242 -2.640255767 0.1953005 -13.51893815 1.209084e-41 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372

243 -0.432754644 0.3685263 -1.17428422 2.402812e-01 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372

244 -0.250677666 0.2076476 -1.20722666 2.273449e-01 PrimeType * VerbType + (1 + PrimeType || Participant) + (0 + VerbType | Participant) + (1 | Prime_Verb) 4261.372

245 3.559300411 0.2752240 12.93237477 2.955469e-38 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) 4385.967

246 -2.714162772 0.2590470 -10.47749065 1.096136e-25 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) 4385.967

247 -0.487372397 0.3046279 -1.59989423 1.096220e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) 4385.967

248 -0.088487307 0.3191281 -0.27727831 7.815664e-01 PrimeType * VerbType + (1 + PrimeType * VerbType | Participant) 4385.967

249 3.436633067 0.2185306 15.72609232 1.002076e-55 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) 4381.520

250 -2.579212937 0.1973948 -13.06626493 5.132434e-39 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) 4381.520

251 -0.405812770 0.1946000 -2.08536893 3.703583e-02 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) 4381.520

252 -0.185068588 0.2094902 -0.88342370 3.770074e-01 PrimeType * VerbType + (1 + PrimeType + VerbType | Participant) 4381.520

253 3.263365655 0.1955127 16.69132321 1.515738e-62 PrimeType * VerbType + (1 + PrimeType | Participant) 4382.196

254 -2.433314432 0.1842750 -13.20479958 8.231852e-40 PrimeType * VerbType + (1 + PrimeType | Participant) 4382.196

255 -0.113298173 0.1511521 -0.74956391 4.535174e-01 PrimeType * VerbType +

(1 + PrimeType | Participant) 4382.196
256 -0.450287060 0.1794992 -2.50857427 1.212195e-02 PrimeType * VerbType +
(1 + PrimeType | Participant) 4382.196
257 3.151893475 0.1681362 18.74607262 2.084266e-78 PrimeType * VerbType +
(1 + VerbType | Participant) 4396.108
258 -2.297541342 0.1421820 -16.15915421 9.789558e-59 PrimeType * VerbType +
(1 + VerbType | Participant) 4396.108
259 -0.318201738 0.1774319 -1.79337365 7.291320e-02 PrimeType * VerbType +
(1 + VerbType | Participant) 4396.108
260 -0.277684018 0.1941471 -1.43027606 1.526378e-01 PrimeType * VerbType +
(1 + VerbType | Participant) 4396.108
261 3.025022557 0.1486942 20.34391959 5.255742e-92 PrimeType * VerbType +
(1 | Participant) 4396.440
262 -2.201308580 0.1307858 -16.83140911 1.436425e-63 PrimeType * VerbType +
(1 | Participant) 4396.440
263 -0.104879352 0.1445510 -0.72555235 4.681132e-01 PrimeType * VerbType +
(1 | Participant) 4396.440
264 -0.459047109 0.1728813 -2.65527345 7.924414e-03 PrimeType * VerbType +
(1 | Participant) 4396.440
265 3.559281655 0.2752574 12.93073845 3.019051e-38 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) 4385.967
266 -2.714145932 0.2590824 -10.47599438 1.113610e-25 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) 4385.967
267 -0.487361626 0.3046801 -1.59958461 1.096908e-01 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) 4385.967
268 -0.088496397 0.3191838 -0.27725846 7.815817e-01 PrimeType * VerbType +
(0 + PrimeType * VerbType | Participant) 4385.967
269 3.436637158 0.2185135 15.72734770 9.824086e-56 PrimeType * VerbType +
(0 + PrimeType + VerbType | Participant) 4381.520
270 -2.579216009 0.1973799 -13.06726714 5.065276e-39 PrimeType * VerbType +
(0 + PrimeType + VerbType | Participant) 4381.520
271 -0.405815387 0.1945843 -2.08555056 3.701935e-02 PrimeType * VerbType +

(0 + PrimeType + VerbType | Participant) 4381.520
272 -0.185066394 0.2094767 -0.88346998 3.769824e-01 PrimeType * VerbType +
(0 + PrimeType + VerbType | Participant) 4381.520
273 3.263362584 0.1954898 16.69325892 1.467376e-62 PrimeType * VerbType +
(0 + PrimeType | Participant) 4382.196
274 -2.433311976 0.1842492 -13.20663780 8.033323e-40 PrimeType * VerbType +
(0 + PrimeType | Participant) 4382.196
275 -0.113297803 0.1511488 -0.74957804 4.535089e-01 PrimeType * VerbType +
(0 + PrimeType | Participant) 4382.196
276 -0.450287063 0.1794956 -2.50862386 1.212025e-02 PrimeType * VerbType +
(0 + PrimeType | Participant) 4382.196
277 3.151890769 0.1681442 18.74516262 2.120227e-78 PrimeType * VerbType +
(0 + VerbType | Participant) 4396.108
278 -2.297538827 0.1421906 -16.15816760 9.947480e-59 PrimeType * VerbType +
(0 + VerbType | Participant) 4396.108
279 -0.318198591 0.1774378 -1.79329612 7.292559e-02 PrimeType * VerbType +
(0 + VerbType | Participant) 4396.108
280 -0.277686964 0.1941546 -1.43023629 1.526492e-01 PrimeType * VerbType +
(0 + VerbType | Participant) 4396.108
281 3.559287566 0.2752071 12.93312542 2.926749e-38 PrimeType * VerbType +
(1 + PrimeType * VerbType || Participant) 4399.967
282 -2.714151636 0.2590391 -10.47776850 1.092921e-25 PrimeType * VerbType +
(1 + PrimeType * VerbType || Participant) 4399.967
283 -0.487365003 0.3046344 -1.59983571 1.096350e-01 PrimeType * VerbType +
(1 + PrimeType * VerbType || Participant) 4399.967
284 -0.088493327 0.3191425 -0.27728465 7.815615e-01 PrimeType * VerbType +
(1 + PrimeType * VerbType || Participant) 4399.967
285 3.358232282 0.2048083 16.39695120 2.010793e-60 PrimeType * VerbType +
(1 + PrimeType + VerbType || Participant) 4386.318
286 -2.494689212 0.1867258 -13.36017078 1.033268e-40 PrimeType * VerbType +
(1 + PrimeType + VerbType || Participant) 4386.318
287 -0.301602863 0.1845973 -1.63384240 1.022919e-01 PrimeType * VerbType +

(1 + PrimeType + VerbType || Participant) 4386.318

288 -0.297477318 0.1987367 -1.49684158 1.344345e-01 PrimeType * VerbType + (1 + PrimeType + VerbType || Participant) 4386.318

289 3.263371143 0.1954906 16.69323826 1.467884e-62 PrimeType * VerbType + (1 + PrimeType || Participant) 4384.196

290 -2.433320133 0.1842502 -13.20660963 8.036329e-40 PrimeType * VerbType + (1 + PrimeType || Participant) 4384.196

291 -0.113301336 0.1511407 -0.74964144 4.534707e-01 PrimeType * VerbType + (1 + PrimeType || Participant) 4384.196

292 -0.450282857 0.1794866 -2.50872634 1.211673e-02 PrimeType * VerbType + (1 + PrimeType || Participant) 4384.196

293 3.151894490 0.1681327 18.74647185 2.068681e-78 PrimeType * VerbType + (1 + VerbType || Participant) 4398.108

294 -2.297542372 0.1421775 -16.15968186 9.706127e-59 PrimeType * VerbType + (1 + VerbType || Participant) 4398.108

295 -0.318205553 0.1774206 -1.79350937 7.289151e-02 PrimeType * VerbType + (1 + VerbType || Participant) 4398.108

296 -0.277679542 0.1941327 -1.43035947 1.526139e-01 PrimeType * VerbType + (1 + VerbType || Participant) 4398.108

	BIC	logLik	deviance	df.resid	Effect
1	4324.325	-2089.226	4178.453	5311	(Intercept)
2	4324.325	-2089.226	4178.453	5311	PrimeTypeP
3	4324.325	-2089.226	4178.453	5311	VerbTypeTE
4	4324.325	-2089.226	4178.453	5311	PrimeTypeP:VerbTypeTE
5	4291.827	-2090.139	4180.278	5315	(Intercept)
6	4291.827	-2090.139	4180.278	5315	PrimeTypeP
7	4291.827	-2090.139	4180.278	5315	VerbTypeTE
8	4291.827	-2090.139	4180.278	5315	PrimeTypeP:VerbTypeTE
9	4277.379	-2095.786	4191.572	5318	(Intercept)
10	4277.379	-2095.786	4191.572	5318	PrimeTypeP
11	4277.379	-2095.786	4191.572	5318	VerbTypeTE
12	4277.379	-2095.786	4191.572	5318	PrimeTypeP:VerbTypeTE

13	4288.246	-2101.219	4202.439	5318	(Intercept)
14	4288.246	-2101.219	4202.439	5318	PrimeTypeP
15	4288.246	-2101.219	4202.439	5318	VerbTypeTE
16	4288.246	-2101.219	4202.439	5318	PrimeTypeP:VerbTypeTE
17	4279.771	-2105.563	4211.125	5320	(Intercept)
18	4279.771	-2105.563	4211.125	5320	PrimeTypeP
19	4279.771	-2105.563	4211.125	5320	VerbTypeTE
20	4279.771	-2105.563	4211.125	5320	PrimeTypeP:VerbTypeTE
21	5191.593	-2565.764	5131.528	5321	(Intercept)
22	5191.593	-2565.764	5131.528	5321	PrimeTypeP
23	5191.593	-2565.764	5131.528	5321	VerbTypeTE
24	5191.593	-2565.764	5131.528	5321	PrimeTypeP:VerbTypeTE
25	4358.870	-2115.080	4230.159	5313	(Intercept)
26	4358.870	-2115.080	4230.159	5313	PrimeTypeP
27	4358.870	-2115.080	4230.159	5313	VerbTypeTE
28	4358.870	-2115.080	4230.159	5313	PrimeTypeP:VerbTypeTE
29	4328.849	-2117.231	4234.461	5317	(Intercept)
30	4328.849	-2117.231	4234.461	5317	PrimeTypeP
31	4328.849	-2117.231	4234.461	5317	VerbTypeTE
32	4328.849	-2117.231	4234.461	5317	PrimeTypeP:VerbTypeTE
33	4312.634	-2121.994	4243.988	5320	(Intercept)
34	4312.634	-2121.994	4243.988	5320	PrimeTypeP
35	4312.634	-2121.994	4243.988	5320	VerbTypeTE
36	4312.634	-2121.994	4243.988	5320	PrimeTypeP:VerbTypeTE
37	4327.060	-2129.207	4258.414	5320	(Intercept)
38	4327.060	-2129.207	4258.414	5320	PrimeTypeP
39	4327.060	-2129.207	4258.414	5320	VerbTypeTE
40	4327.060	-2129.207	4258.414	5320	PrimeTypeP:VerbTypeTE
41	4316.659	-2132.588	4265.175	5322	(Intercept)
42	4316.659	-2132.588	4265.175	5322	PrimeTypeP
43	4316.659	-2132.588	4265.175	5322	VerbTypeTE
44	4316.659	-2132.588	4265.175	5322	PrimeTypeP:VerbTypeTE

45	5211.830	-2584.463	5168.927	5323	(Intercept)
46	5211.830	-2584.463	5168.927	5323	PrimeTypeP
47	5211.830	-2584.463	5168.927	5323	VerbTypeTE
48	5211.830	-2584.463	5168.927	5323	PrimeTypeP:VerbTypeTE
49	4324.325	-2089.226	4178.453	5311	(Intercept)
50	4324.325	-2089.226	4178.453	5311	PrimeTypeP
51	4324.325	-2089.226	4178.453	5311	VerbTypeTE
52	4324.325	-2089.226	4178.453	5311	PrimeTypeP:VerbTypeTE
53	4291.827	-2090.139	4180.278	5315	(Intercept)
54	4291.827	-2090.139	4180.278	5315	PrimeTypeP
55	4291.827	-2090.139	4180.278	5315	VerbTypeTE
56	4291.827	-2090.139	4180.278	5315	PrimeTypeP:VerbTypeTE
57	4277.379	-2095.786	4191.572	5318	(Intercept)
58	4277.379	-2095.786	4191.572	5318	PrimeTypeP
59	4277.379	-2095.786	4191.572	5318	VerbTypeTE
60	4277.379	-2095.786	4191.572	5318	PrimeTypeP:VerbTypeTE
61	4288.246	-2101.219	4202.439	5318	(Intercept)
62	4288.246	-2101.219	4202.439	5318	PrimeTypeP
63	4288.246	-2101.219	4202.439	5318	VerbTypeTE
64	4288.246	-2101.219	4202.439	5318	PrimeTypeP:VerbTypeTE
65	4279.771	-2105.563	4211.125	5320	(Intercept)
66	4279.771	-2105.563	4211.125	5320	PrimeTypeP
67	4279.771	-2105.563	4211.125	5320	VerbTypeTE
68	4279.771	-2105.563	4211.125	5320	PrimeTypeP:VerbTypeTE
69	5191.593	-2565.764	5131.528	5321	(Intercept)
70	5191.593	-2565.764	5131.528	5321	PrimeTypeP
71	5191.593	-2565.764	5131.528	5321	VerbTypeTE
72	5191.593	-2565.764	5131.528	5321	PrimeTypeP:VerbTypeTE
73	4324.325	-2089.226	4178.453	5311	(Intercept)
74	4324.325	-2089.226	4178.453	5311	PrimeTypeP
75	4324.325	-2089.226	4178.453	5311	VerbTypeTE
76	4324.325	-2089.226	4178.453	5311	PrimeTypeP:VerbTypeTE

77	4291.827	-2090.139	4180.278	5315	(Intercept)
78	4291.827	-2090.139	4180.278	5315	PrimeTypeP
79	4291.827	-2090.139	4180.278	5315	VerbTypeTE
80	4291.827	-2090.139	4180.278	5315	PrimeTypeP:VerbTypeTE
81	4277.379	-2095.786	4191.572	5318	(Intercept)
82	4277.379	-2095.786	4191.572	5318	PrimeTypeP
83	4277.379	-2095.786	4191.572	5318	VerbTypeTE
84	4277.379	-2095.786	4191.572	5318	PrimeTypeP:VerbTypeTE
85	4288.246	-2101.219	4202.439	5318	(Intercept)
86	4288.246	-2101.219	4202.439	5318	PrimeTypeP
87	4288.246	-2101.219	4202.439	5318	VerbTypeTE
88	4288.246	-2101.219	4202.439	5318	PrimeTypeP:VerbTypeTE
89	4358.870	-2115.080	4230.159	5313	(Intercept)
90	4358.870	-2115.080	4230.159	5313	PrimeTypeP
91	4358.870	-2115.080	4230.159	5313	VerbTypeTE
92	4358.870	-2115.080	4230.159	5313	PrimeTypeP:VerbTypeTE
93	4328.849	-2117.231	4234.461	5317	(Intercept)
94	4328.849	-2117.231	4234.461	5317	PrimeTypeP
95	4328.849	-2117.231	4234.461	5317	VerbTypeTE
96	4328.849	-2117.231	4234.461	5317	PrimeTypeP:VerbTypeTE
97	4312.634	-2121.994	4243.988	5320	(Intercept)
98	4312.634	-2121.994	4243.988	5320	PrimeTypeP
99	4312.634	-2121.994	4243.988	5320	VerbTypeTE
100	4312.634	-2121.994	4243.988	5320	PrimeTypeP:VerbTypeTE
101	4327.060	-2129.207	4258.414	5320	(Intercept)
102	4327.060	-2129.207	4258.414	5320	PrimeTypeP
103	4327.060	-2129.207	4258.414	5320	VerbTypeTE
104	4327.060	-2129.207	4258.414	5320	PrimeTypeP:VerbTypeTE
105	4324.325	-2089.226	4178.453	5311	(Intercept)
106	4324.325	-2089.226	4178.453	5311	PrimeTypeP
107	4324.325	-2089.226	4178.453	5311	VerbTypeTE
108	4324.325	-2089.226	4178.453	5311	PrimeTypeP:VerbTypeTE

109	4291.827	-2090.139	4180.278	5315	(Intercept)
110	4291.827	-2090.139	4180.278	5315	PrimeTypeP
111	4291.827	-2090.139	4180.278	5315	VerbTypeTE
112	4291.827	-2090.139	4180.278	5315	PrimeTypeP:VerbTypeTE
113	4277.379	-2095.786	4191.572	5318	(Intercept)
114	4277.379	-2095.786	4191.572	5318	PrimeTypeP
115	4277.379	-2095.786	4191.572	5318	VerbTypeTE
116	4277.379	-2095.786	4191.572	5318	PrimeTypeP:VerbTypeTE
117	4288.246	-2101.219	4202.439	5318	(Intercept)
118	4288.246	-2101.219	4202.439	5318	PrimeTypeP
119	4288.246	-2101.219	4202.439	5318	VerbTypeTE
120	4288.246	-2101.219	4202.439	5318	PrimeTypeP:VerbTypeTE
121	4384.390	-2089.226	4178.453	5304	(Intercept)
122	4384.390	-2089.226	4178.453	5304	PrimeTypeP
123	4384.390	-2089.226	4178.453	5304	VerbTypeTE
124	4384.390	-2089.226	4178.453	5304	PrimeTypeP:VerbTypeTE
125	4302.324	-2091.097	4182.194	5314	(Intercept)
126	4302.324	-2091.097	4182.194	5314	PrimeTypeP
127	4302.324	-2091.097	4182.194	5314	VerbTypeTE
128	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
129	4285.960	-2095.786	4191.572	5317	(Intercept)
130	4285.960	-2095.786	4191.572	5317	PrimeTypeP
131	4285.960	-2095.786	4191.572	5317	VerbTypeTE
132	4285.960	-2095.786	4191.572	5317	PrimeTypeP:VerbTypeTE
133	4296.827	-2101.219	4202.439	5317	(Intercept)
134	4296.827	-2101.219	4202.439	5317	PrimeTypeP
135	4296.827	-2101.219	4202.439	5317	VerbTypeTE
136	4296.827	-2101.219	4202.439	5317	PrimeTypeP:VerbTypeTE
137	4418.936	-2115.080	4230.159	5306	(Intercept)
138	4418.936	-2115.080	4230.159	5306	PrimeTypeP
139	4418.936	-2115.080	4230.159	5306	VerbTypeTE
140	4418.936	-2115.080	4230.159	5306	PrimeTypeP:VerbTypeTE

141	4340.340	-2118.686	4237.372	5316	(Intercept)
142	4340.340	-2118.686	4237.372	5316	PrimeTypeP
143	4340.340	-2118.686	4237.372	5316	VerbTypeTE
144	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE
145	4321.215	-2121.994	4243.988	5319	(Intercept)
146	4321.215	-2121.994	4243.988	5319	PrimeTypeP
147	4321.215	-2121.994	4243.988	5319	VerbTypeTE
148	4321.215	-2121.994	4243.988	5319	PrimeTypeP:VerbTypeTE
149	4335.641	-2129.207	4258.414	5319	(Intercept)
150	4335.641	-2129.207	4258.414	5319	PrimeTypeP
151	4335.641	-2129.207	4258.414	5319	VerbTypeTE
152	4335.641	-2129.207	4258.414	5319	PrimeTypeP:VerbTypeTE
153	4384.390	-2089.226	4178.453	5304	(Intercept)
154	4384.390	-2089.226	4178.453	5304	PrimeTypeP
155	4384.390	-2089.226	4178.453	5304	VerbTypeTE
156	4384.390	-2089.226	4178.453	5304	PrimeTypeP:VerbTypeTE
157	4302.324	-2091.097	4182.194	5314	(Intercept)
158	4302.324	-2091.097	4182.194	5314	PrimeTypeP
159	4302.324	-2091.097	4182.194	5314	VerbTypeTE
160	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
161	4285.960	-2095.786	4191.572	5317	(Intercept)
162	4285.960	-2095.786	4191.572	5317	PrimeTypeP
163	4285.960	-2095.786	4191.572	5317	VerbTypeTE
164	4285.960	-2095.786	4191.572	5317	PrimeTypeP:VerbTypeTE
165	4296.827	-2101.219	4202.439	5317	(Intercept)
166	4296.827	-2101.219	4202.439	5317	PrimeTypeP
167	4296.827	-2101.219	4202.439	5317	VerbTypeTE
168	4296.827	-2101.219	4202.439	5317	PrimeTypeP:VerbTypeTE
169	4285.960	-2095.786	4191.572	5317	(Intercept)
170	4285.960	-2095.786	4191.572	5317	PrimeTypeP
171	4285.960	-2095.786	4191.572	5317	VerbTypeTE
172	4285.960	-2095.786	4191.572	5317	PrimeTypeP:VerbTypeTE

173	4296.827	-2101.219	4202.439	5317	(Intercept)
174	4296.827	-2101.219	4202.439	5317	PrimeTypeP
175	4296.827	-2101.219	4202.439	5317	VerbTypeTE
176	4296.827	-2101.219	4202.439	5317	PrimeTypeP:VerbTypeTE
177	4392.971	-2089.226	4178.453	5303	(Intercept)
178	4392.971	-2089.226	4178.453	5303	PrimeTypeP
179	4392.971	-2089.226	4178.453	5303	VerbTypeTE
180	4392.971	-2089.226	4178.453	5303	PrimeTypeP:VerbTypeTE
181	4302.324	-2091.097	4182.194	5314	(Intercept)
182	4302.324	-2091.097	4182.194	5314	PrimeTypeP
183	4302.324	-2091.097	4182.194	5314	VerbTypeTE
184	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
185	4302.324	-2091.097	4182.194	5314	(Intercept)
186	4302.324	-2091.097	4182.194	5314	PrimeTypeP
187	4302.324	-2091.097	4182.194	5314	VerbTypeTE
188	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
189	4310.905	-2091.097	4182.194	5313	(Intercept)
190	4310.905	-2091.097	4182.194	5313	PrimeTypeP
191	4310.905	-2091.097	4182.194	5313	VerbTypeTE
192	4310.905	-2091.097	4182.194	5313	PrimeTypeP:VerbTypeTE
193	4310.905	-2091.097	4182.194	5313	(Intercept)
194	4310.905	-2091.097	4182.194	5313	PrimeTypeP
195	4310.905	-2091.097	4182.194	5313	VerbTypeTE
196	4310.905	-2091.097	4182.194	5313	PrimeTypeP:VerbTypeTE
197	4302.324	-2091.097	4182.194	5314	(Intercept)
198	4302.324	-2091.097	4182.194	5314	PrimeTypeP
199	4302.324	-2091.097	4182.194	5314	VerbTypeTE
200	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
201	4340.340	-2118.686	4237.372	5316	(Intercept)
202	4340.340	-2118.686	4237.372	5316	PrimeTypeP
203	4340.340	-2118.686	4237.372	5316	VerbTypeTE
204	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE

205	4340.340	-2118.686	4237.372	5316	(Intercept)
206	4340.340	-2118.686	4237.372	5316	PrimeTypeP
207	4340.340	-2118.686	4237.372	5316	VerbTypeTE
208	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE
209	4340.340	-2118.686	4237.372	5316	(Intercept)
210	4340.340	-2118.686	4237.372	5316	PrimeTypeP
211	4340.340	-2118.686	4237.372	5316	VerbTypeTE
212	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE
213	4458.706	-2182.159	4364.318	5317	(Intercept)
214	4458.706	-2182.159	4364.318	5317	PrimeTypeP
215	4458.706	-2182.159	4364.318	5317	VerbTypeTE
216	4458.706	-2182.159	4364.318	5317	PrimeTypeP:VerbTypeTE
217	4458.706	-2182.159	4364.318	5317	(Intercept)
218	4458.706	-2182.159	4364.318	5317	PrimeTypeP
219	4458.706	-2182.159	4364.318	5317	VerbTypeTE
220	4458.706	-2182.159	4364.318	5317	PrimeTypeP:VerbTypeTE
221	4302.324	-2091.097	4182.194	5314	(Intercept)
222	4302.324	-2091.097	4182.194	5314	PrimeTypeP
223	4302.324	-2091.097	4182.194	5314	VerbTypeTE
224	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
225	4302.324	-2091.097	4182.194	5314	(Intercept)
226	4302.324	-2091.097	4182.194	5314	PrimeTypeP
227	4302.324	-2091.097	4182.194	5314	VerbTypeTE
228	4302.324	-2091.097	4182.194	5314	PrimeTypeP:VerbTypeTE
229	4310.905	-2091.097	4182.194	5313	(Intercept)
230	4310.905	-2091.097	4182.194	5313	PrimeTypeP
231	4310.905	-2091.097	4182.194	5313	VerbTypeTE
232	4310.905	-2091.097	4182.194	5313	PrimeTypeP:VerbTypeTE
233	4340.340	-2118.686	4237.372	5316	(Intercept)
234	4340.340	-2118.686	4237.372	5316	PrimeTypeP
235	4340.340	-2118.686	4237.372	5316	VerbTypeTE
236	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE

237	4340.340	-2118.686	4237.372	5316	(Intercept)
238	4340.340	-2118.686	4237.372	5316	PrimeTypeP
239	4340.340	-2118.686	4237.372	5316	VerbTypeTE
240	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE
241	4340.340	-2118.686	4237.372	5316	(Intercept)
242	4340.340	-2118.686	4237.372	5316	PrimeTypeP
243	4340.340	-2118.686	4237.372	5316	VerbTypeTE
244	4340.340	-2118.686	4237.372	5316	PrimeTypeP:VerbTypeTE
245	4478.097	-2178.983	4357.967	5314	(Intercept)
246	4478.097	-2178.983	4357.967	5314	PrimeTypeP
247	4478.097	-2178.983	4357.967	5314	VerbTypeTE
248	4478.097	-2178.983	4357.967	5314	PrimeTypeP:VerbTypeTE
249	4447.327	-2180.760	4361.520	5318	(Intercept)
250	4447.327	-2180.760	4361.520	5318	PrimeTypeP
251	4447.327	-2180.760	4361.520	5318	VerbTypeTE
252	4447.327	-2180.760	4361.520	5318	PrimeTypeP:VerbTypeTE
253	4428.261	-2184.098	4368.196	5321	(Intercept)
254	4428.261	-2184.098	4368.196	5321	PrimeTypeP
255	4428.261	-2184.098	4368.196	5321	VerbTypeTE
256	4428.261	-2184.098	4368.196	5321	PrimeTypeP:VerbTypeTE
257	4442.173	-2191.054	4382.108	5321	(Intercept)
258	4442.173	-2191.054	4382.108	5321	PrimeTypeP
259	4442.173	-2191.054	4382.108	5321	VerbTypeTE
260	4442.173	-2191.054	4382.108	5321	PrimeTypeP:VerbTypeTE
261	4429.343	-2193.220	4386.440	5323	(Intercept)
262	4429.343	-2193.220	4386.440	5323	PrimeTypeP
263	4429.343	-2193.220	4386.440	5323	VerbTypeTE
264	4429.343	-2193.220	4386.440	5323	PrimeTypeP:VerbTypeTE
265	4478.097	-2178.983	4357.967	5314	(Intercept)
266	4478.097	-2178.983	4357.967	5314	PrimeTypeP
267	4478.097	-2178.983	4357.967	5314	VerbTypeTE
268	4478.097	-2178.983	4357.967	5314	PrimeTypeP:VerbTypeTE

269	4447.327	-2180.760	4361.520	5318	(Intercept)
270	4447.327	-2180.760	4361.520	5318	PrimeTypeP
271	4447.327	-2180.760	4361.520	5318	VerbTypeTE
272	4447.327	-2180.760	4361.520	5318	PrimeTypeP:VerbTypeTE
273	4428.261	-2184.098	4368.196	5321	(Intercept)
274	4428.261	-2184.098	4368.196	5321	PrimeTypeP
275	4428.261	-2184.098	4368.196	5321	VerbTypeTE
276	4428.261	-2184.098	4368.196	5321	PrimeTypeP:VerbTypeTE
277	4442.173	-2191.054	4382.108	5321	(Intercept)
278	4442.173	-2191.054	4382.108	5321	PrimeTypeP
279	4442.173	-2191.054	4382.108	5321	VerbTypeTE
280	4442.173	-2191.054	4382.108	5321	PrimeTypeP:VerbTypeTE
281	4538.162	-2178.983	4357.967	5307	(Intercept)
282	4538.162	-2178.983	4357.967	5307	PrimeTypeP
283	4538.162	-2178.983	4357.967	5307	VerbTypeTE
284	4538.162	-2178.983	4357.967	5307	PrimeTypeP:VerbTypeTE
285	4458.706	-2182.159	4364.318	5317	(Intercept)
286	4458.706	-2182.159	4364.318	5317	PrimeTypeP
287	4458.706	-2182.159	4364.318	5317	VerbTypeTE
288	4458.706	-2182.159	4364.318	5317	PrimeTypeP:VerbTypeTE
289	4436.842	-2184.098	4368.196	5320	(Intercept)
290	4436.842	-2184.098	4368.196	5320	PrimeTypeP
291	4436.842	-2184.098	4368.196	5320	VerbTypeTE
292	4436.842	-2184.098	4368.196	5320	PrimeTypeP:VerbTypeTE
293	4450.754	-2191.054	4382.108	5320	(Intercept)
294	4450.754	-2191.054	4382.108	5320	PrimeTypeP
295	4450.754	-2191.054	4382.108	5320	VerbTypeTE
296	4450.754	-2191.054	4382.108	5320	PrimeTypeP:VerbTypeTE

Appendix F. Study 1 Semantics Output

Family: bernoulli

Links: mu = logit

Formula: RecodeStrict ~ PrimeType * SemanticRating + (1 + PrimeType * SemanticRating | Participant) + (1 + PrimeType | Prime_Verb)

Data: WithSemantics (Number of observations: 5328)

Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;

total post-warmup draws = 160000

Group-Level Effects:

~Participant (Number of levels: 240)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	1.79	0.15	1.52	2.11	1.00	45696	82414
sd(PrimeTypeP)	1.02	0.17	0.70	1.35	1.00	22998	36489
sd(SemanticRating)	0.32	0.12	0.07	0.57	1.00	31164	31562
sd(PrimeTypeP:SemanticRating)	0.20	0.14	0.01	0.52	1.00	25504	49248
cor(Intercept,PrimeTypeP)	-0.34	0.15	-0.60	-0.02	1.00	52778	77520
cor(Intercept,SemanticRating)	-0.51	0.24	-0.89	0.05	1.00	65118	75067
cor(PrimeTypeP,SemanticRating)	0.16	0.31	-0.49	0.71	1.00	53955	75229
cor(Intercept,PrimeTypeP:SemanticRating)	-0.09	0.41	-0.81	0.73	1.00	101746	98492
cor(PrimeTypeP,PrimeTypeP:SemanticRating)	0.19	0.41	-0.68				
cor(SemanticRating,PrimeTypeP:SemanticRating)	-0.20	0.45	-0.88				

cor(PrimeTypeP,PrimeTypeP:SemanticRating)	0.86	1.00	88933	107928		
cor(SemanticRating,PrimeTypeP:SemanticRating)	0.72	1.00	60934	103101		

~Prime_Verb (Number of levels: 12)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	0.43	0.17	0.15	0.84	1.00	51093	45710
sd(PrimeTypeP)	1.05	0.31	0.61	1.80	1.00	52318	80114
cor(Intercept,PrimeTypeP)	-0.12	0.36	-0.73	0.63	1.00	32301	45884

Population-Level Effects:

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
Intercept	3.27	0.23	2.84	3.73	1.00	58175	87345
PrimeTypeP	-2.62	0.36	-3.33	-1.92	1.00	51620	73613
SemanticRating	-0.14	0.18	-0.51	0.21	1.00	61603	88239
PrimeTypeP:SemanticRating	-0.15	0.34	-0.82	0.53	1.00	50167	74213

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1)

Appendix G. Study 1 Proportional Surprisal Output

Family: bernoulli
Links: mu = logit
Formula: RecodeStrict ~ PrimeType * PercentagePass + (1 + PrimeType * PercentagePass | Participant) + (1 + PrimeType | Prime_Verb)
Data: WithSurprisal (Number of observations: 5328)
Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;
total post-warmup draws = 160000

Group-Level Effects:
~Participant (Number of levels: 240)

	Estimate	Est.Error	l-95% CI
sd(Intercept)	1.76	0.15	1.49
sd(PrimeTypeP)	1.01	0.17	0.68
sd(PercentagePass)	0.10	0.08	0.00
sd(PrimeTypeP:PercentagePass)	0.15	0.10	0.01
cor(Intercept,PrimeTypeP)	-0.34	0.15	-0.60
cor(Intercept,PercentagePass)	0.02	0.42	-0.76
cor(PrimeTypeP,PercentagePass)	0.14	0.42	-0.72
cor(Intercept,PrimeTypeP:PercentagePass)	-0.23	0.39	-0.86
cor(PrimeTypeP,PrimeTypeP:PercentagePass)	0.09	0.41	-0.73
cor(PercentagePass,PrimeTypeP:PercentagePass)	-0.11	0.45	-0.86

	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	2.08	1.00	46835	79722
sd(PrimeTypeP)	1.34	1.00	22098	35040
sd(PercentagePass)	0.28	1.00	54651	72734
sd(PrimeTypeP:PercentagePass)	0.38	1.00	41386	66870
cor(Intercept,PrimeTypeP)	-0.02	1.00	51237	73492
cor(Intercept,PercentagePass)	0.79	1.00	151471	111980
cor(PrimeTypeP,PercentagePass)	0.85	1.00	125661	116028
cor(Intercept,PrimeTypeP:PercentagePass)	0.63	1.00	143273	107866
cor(PrimeTypeP,PrimeTypeP:PercentagePass)	0.81	1.00	117198	116147

cor(PercentagePass,PrimeTypeP:PercentagePass) 0.77 1.00 87281 114908

~Prime_Verb (Number of levels: 12)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	0.42	0.17	0.15	0.82	1.00	49539	44993
sd(PrimeTypeP)	1.08	0.32	0.63	1.85	1.00	49572	72003
cor(Intercept,PrimeTypeP)	-0.10	0.36	-0.72	0.65	1.00	29374	42866

Population-Level Effects:

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
Intercept	3.22	0.22	2.80	3.67	1.00	60538	90030
PrimeTypeP	-2.59	0.36	-3.32	-1.88	1.00	47971	73788
PercentagePass	0.07	0.16	-0.24	0.39	1.00	80792	90752
PrimeTypeP:PercentagePass	-0.11	0.33	-0.77	0.56	1.00	63027	80752

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1)

Appendix H. Study 1 Chi Output

Family: bernoulli

Links: mu = logit

Formula: RecodeStrict ~ PrimeType * Chi_Directional + (1 + PrimeType * Chi_Directional | Participant) + (1 + PrimeType | Prime_Verb)

Data: WithCounts (Number of observations: 5328)

Draws: 16 chains, each with iter = 10000; warmup = 0; thin = 1;

total post-warmup draws = 160000

Group-Level Effects:

~Participant (Number of levels: 240)

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	1.74	0.15	1.45	2.06	1.00	46901	81840
sd(PrimeTypeP)	1.04	0.18	0.68	1.40	1.00	21674	37359
sd(Chi_Directional)	0.18	0.12	0.01	0.46	1.00	24165	54472
sd(PrimeTypeP:Chi_Directional)	0.21	0.14	0.01	0.53	1.00	27122	50529
cor(Intercept,PrimeTypeP)	-0.36	0.15	-0.63	-0.03	1.00	47649	72492
cor(Intercept,Chi_Directional)	-0.17	0.39	-0.83	0.65	1.00	106921	97810
cor(PrimeTypeP,Chi_Directional)	0.21	0.40	-0.66	0.86	1.00	63983	93928
cor(Intercept,PrimeTypeP:Chi_Directional)	-0.25	0.40	-0.87	0.63	1.00	105872	96516
cor(PrimeTypeP,PrimeTypeP:Chi_Directional)	0.17	0.42	-0.71				
cor(Chi_Directional,PrimeTypeP:Chi_Directional)	-0.05	0.45	-0.83				

cor(PrimeTypeP,PrimeTypeP:Chi_Directional)	0.84	1.00	78741	100679		
cor(Chi_Directional,PrimeTypeP:Chi_Directional)	0.79	1.00	66977	105649		

~Prime_Verb (Number of levels: 12)

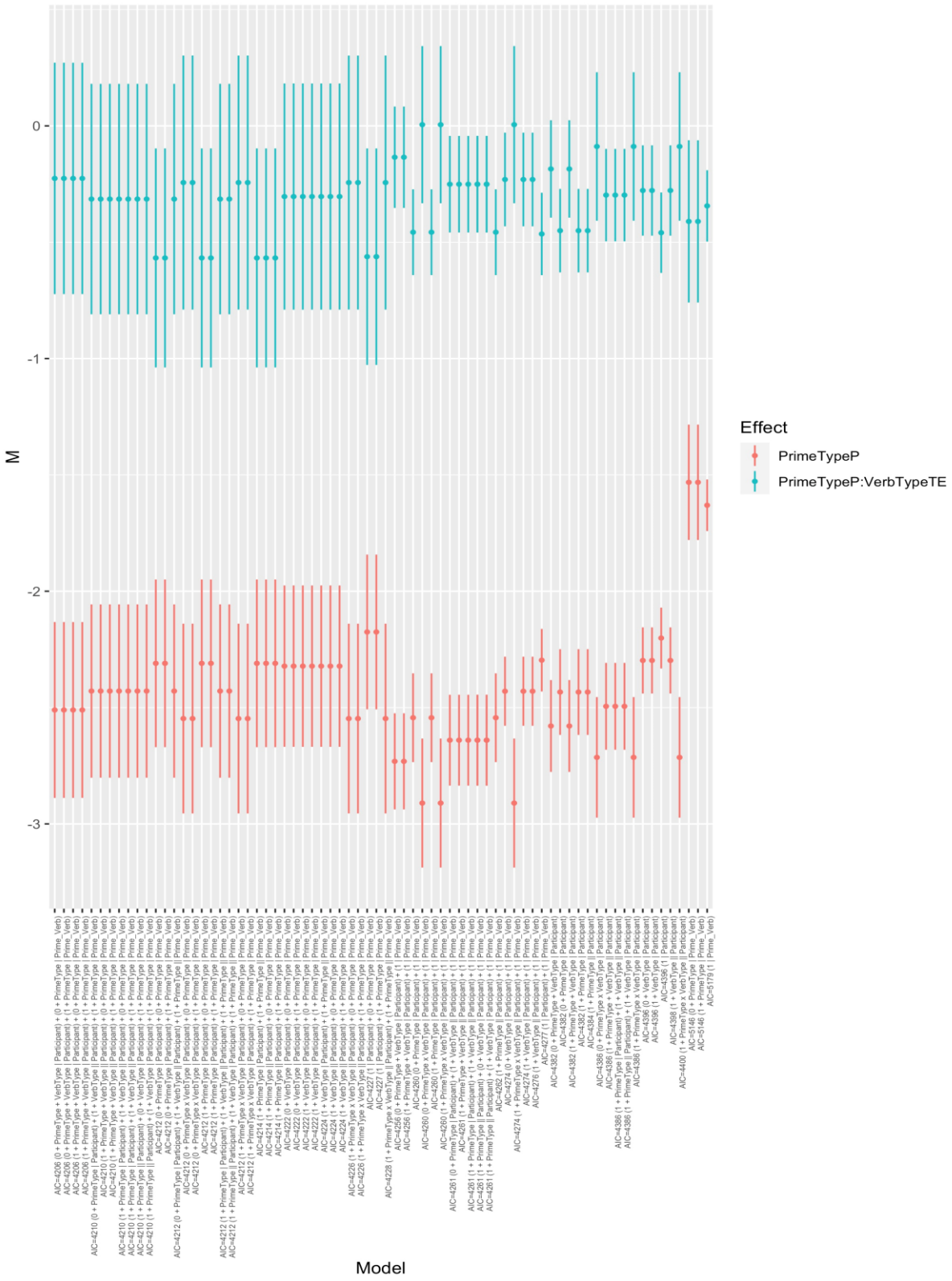
	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
sd(Intercept)	0.42	0.17	0.15	0.82	1.00	45865	41807
sd(PrimeTypeP)	1.08	0.31	0.63	1.84	1.00	48778	71740
cor(Intercept,PrimeTypeP)	-0.10	0.36	-0.72	0.65	1.00	28743	42650

Population-Level Effects:

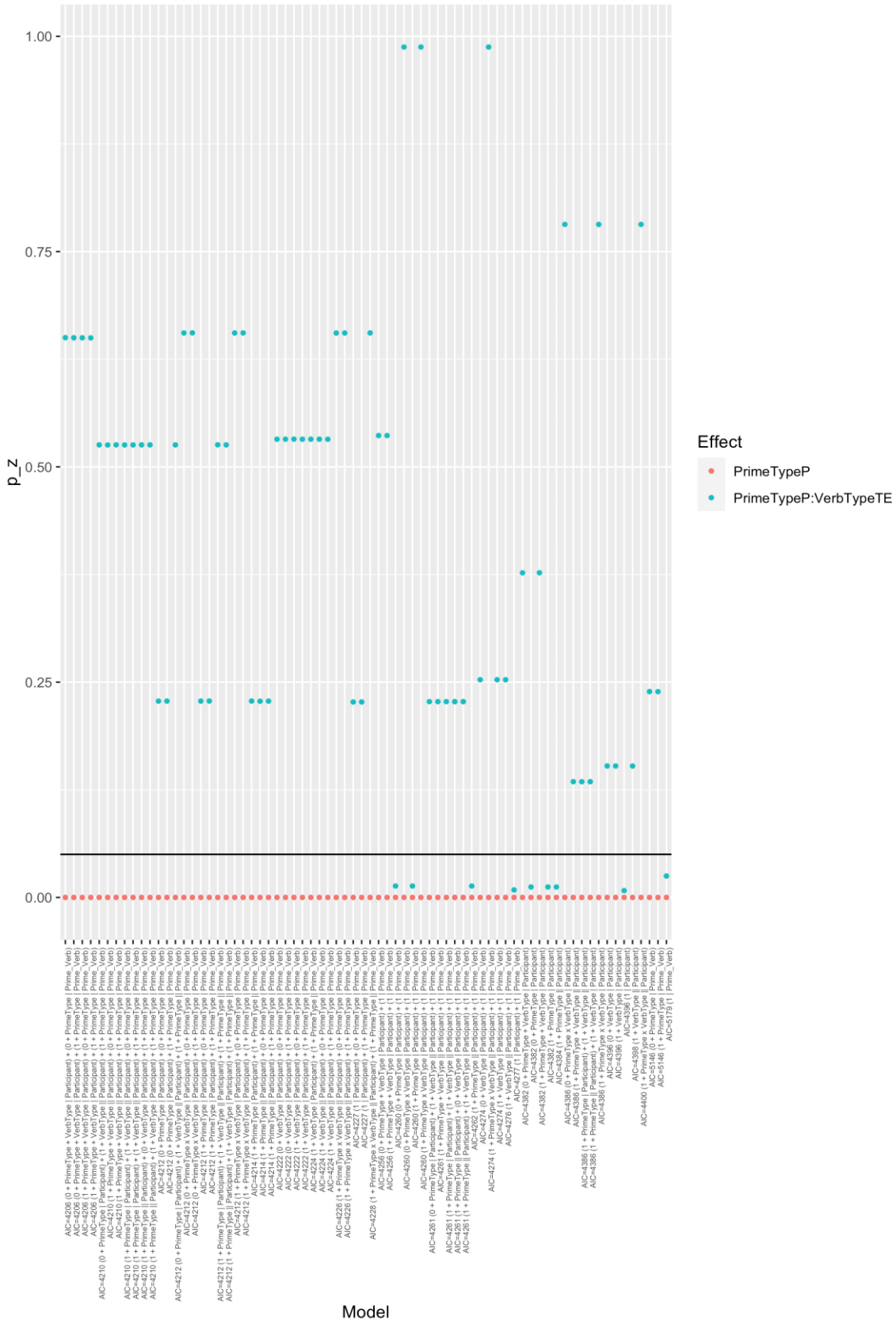
	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS	Tail_ESS
Intercept	3.25	0.26	2.75	3.79	1.00	60036	89829
PrimeTypeP	-2.68	0.47	-3.62	-1.74	1.00	42378	65040
Chi_Directional	0.04	0.22	-0.39	0.48	1.00	68894	91068
PrimeTypeP:Chi_Directional	-0.12	0.46	-1.04	0.80	1.00	49040	70257

Draws were sampled using sample(hmc). For each parameter, Bulk_ESS and Tail_ESS are effective sample size measures, and Rhat is the potential scale reduction factor on split chains (at convergence, Rhat = 1)

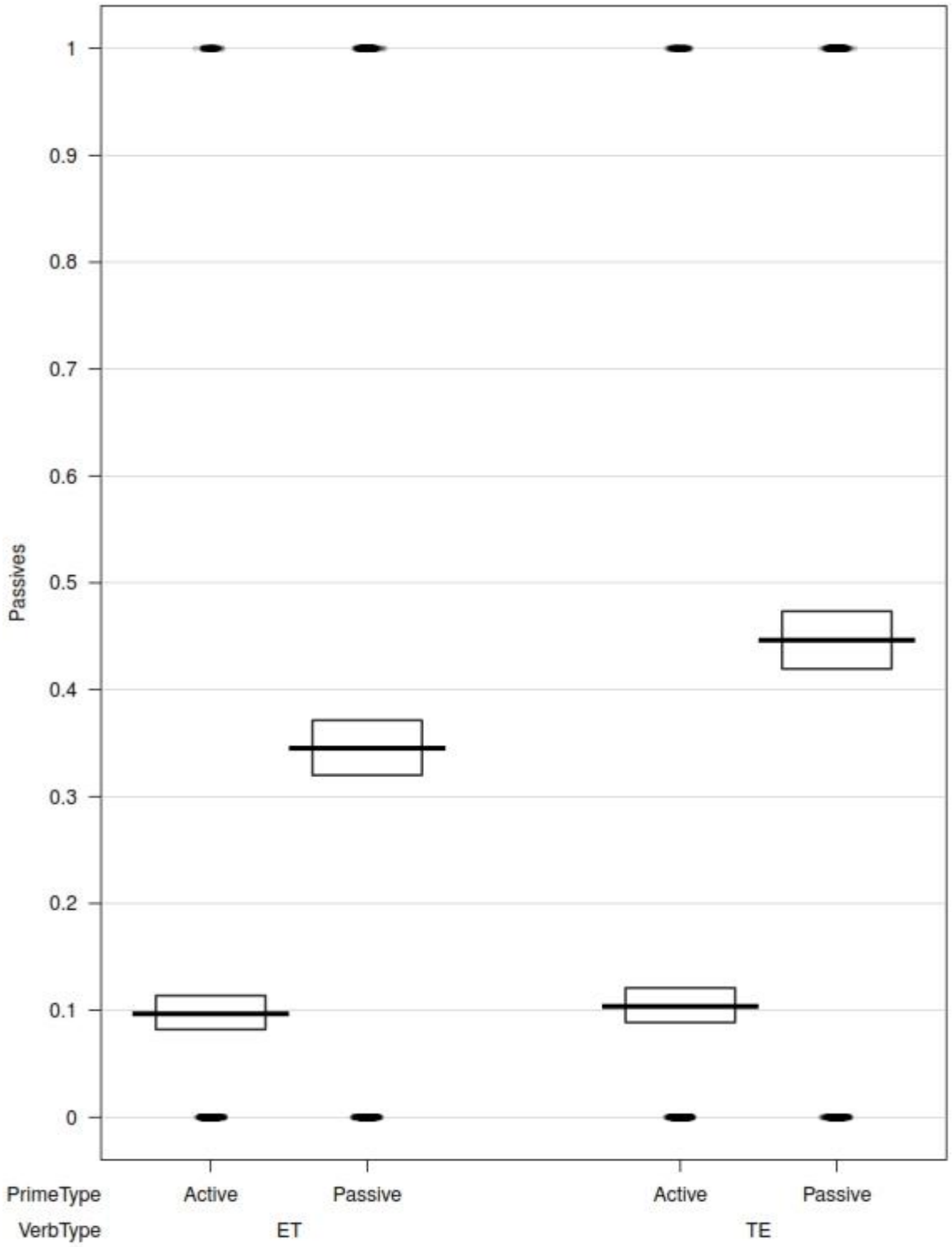
Appendix I. Study 1 Mixed Effects Multiverse



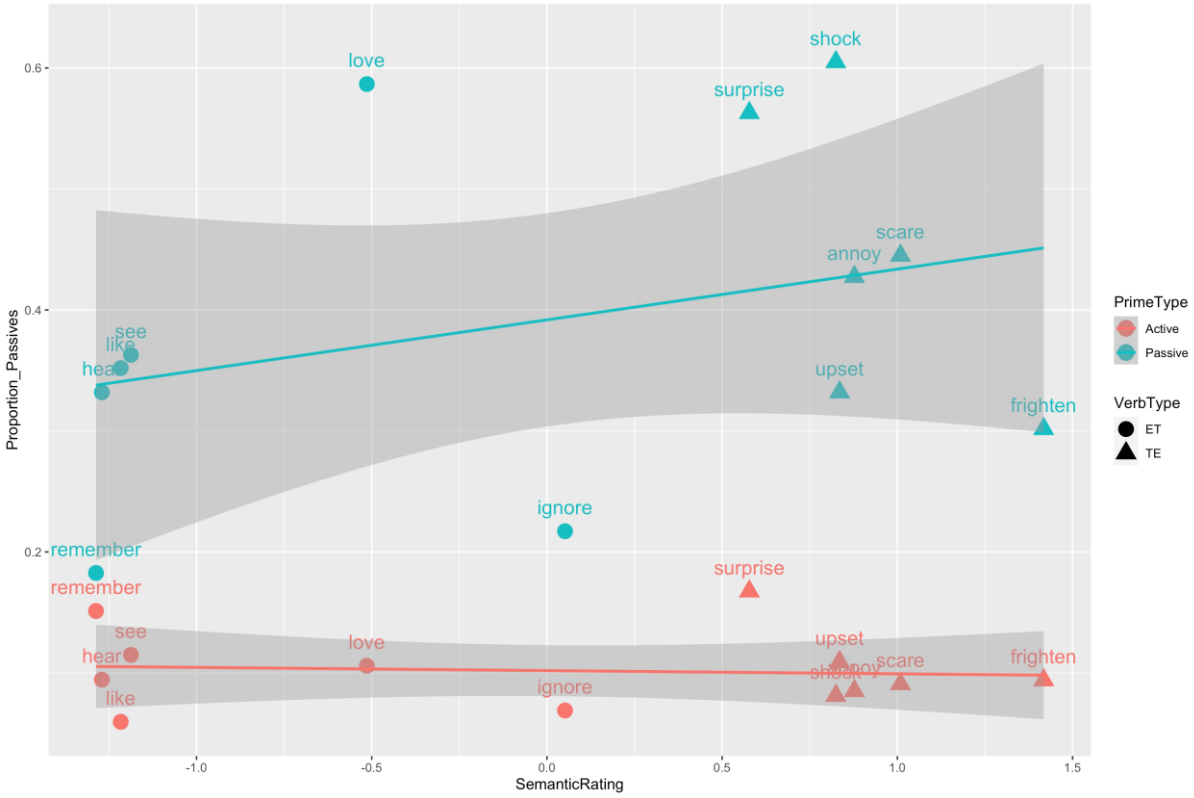
Appendix J. Study 1 p-values Mixed Effects Multiverse



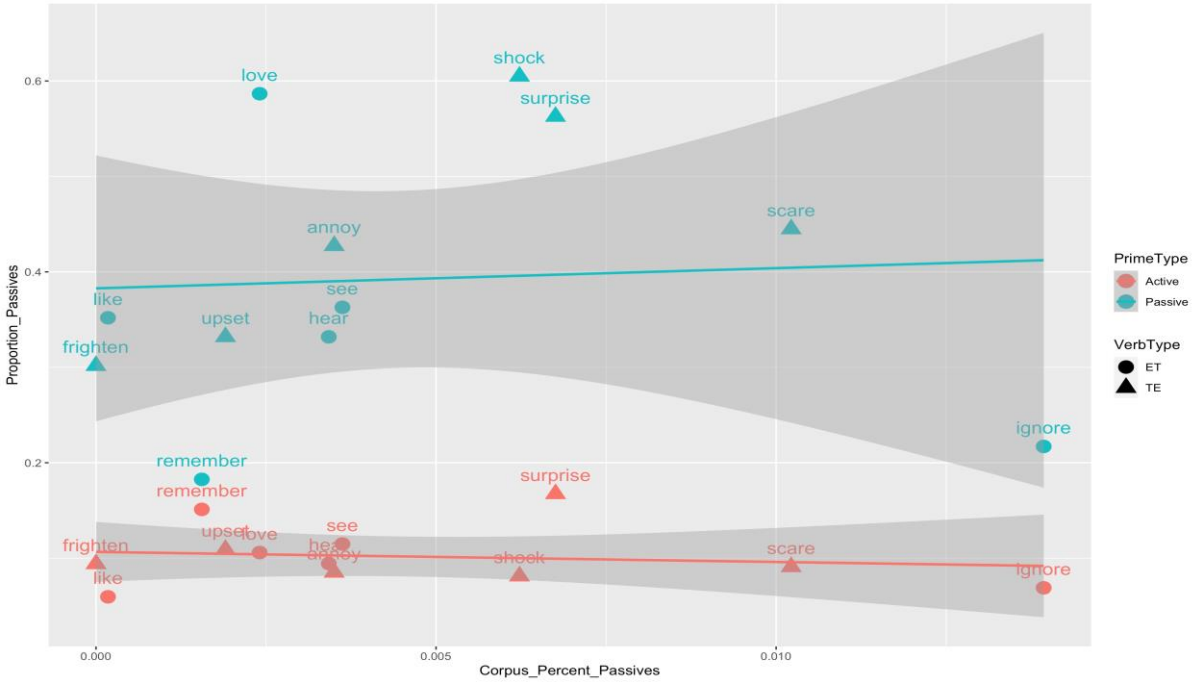
Appendix K. Study 1 Main figure



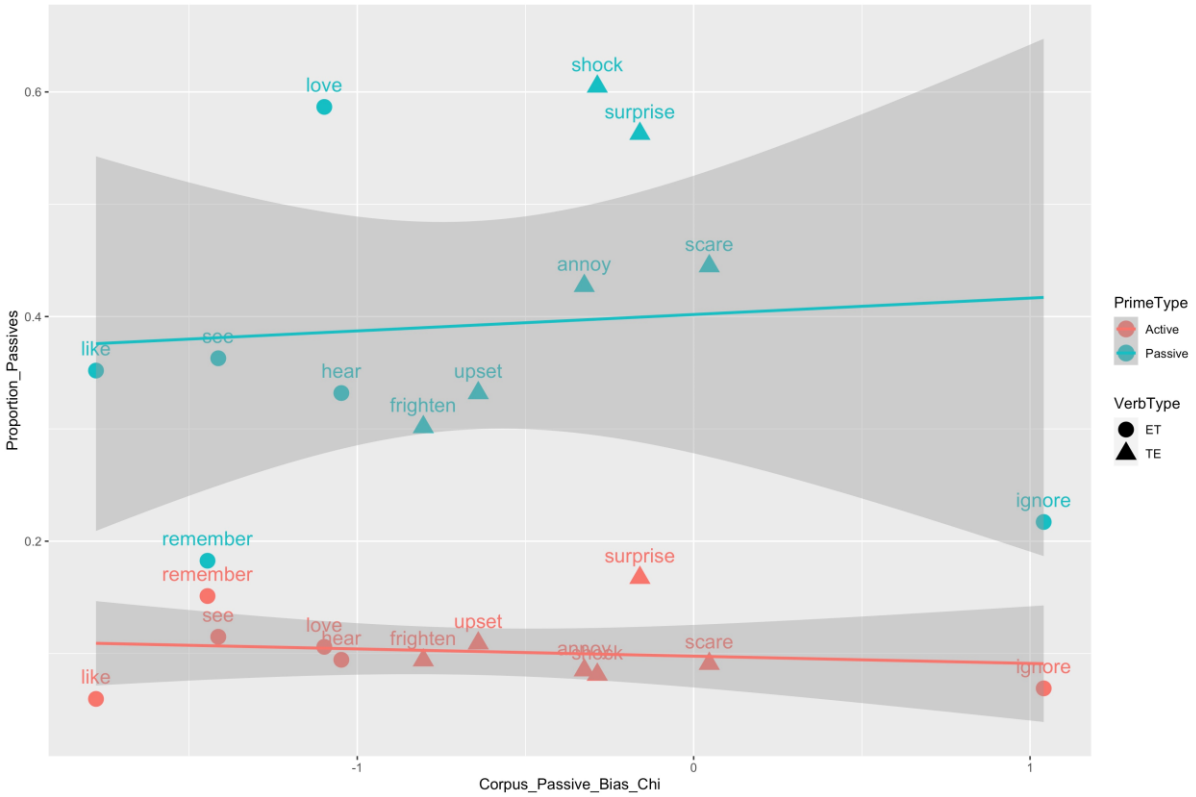
Appendix L. Study 1 Continuous Semantics



Appendix M. Study 1 Proportion



Appendix N. Study 1 Chi



Appendix O. Study 3 Participant Preference Penultimate Row

	Coef.	Std. Error	z	Pr(>|z|)
(Intercept)	71.77	2.13807	33.57	<1e-99
SentenceType: Passive	-14.0136	2.11793	-6.62	<1e-10
SentenceType: Active & ContextType: LowAffected	-3.83	1.73062	-2.21	0.0269
SentenceType: Passive & ContextType: LowAffected	-5.70055	1.7306	-3.29	0.0010

Appendix P. Study 3 Participant Preference Final Row

	Coef.	Std. Error	z	Pr(>|z|)
(Intercept)	71.77	2.13884	33.56	<1e-99
SentenceType: Passive	-14.0136	2.11767	-6.62	<1e-10
ContextType: LowAffected	-3.83	1.73122	-2.21	0.0269
SentenceType: Passive & ContextType: LowAffected	-1.87055	0.858855	-2.18	0.0294

Appendix Q. Sample of participant consent form and information sheet

Participant consent form

Version number & date: Version 4.0, 14th of September 2020
Research ethics approval number: 5322
Title of the research project: Acquisition of Balinese Passives: A Construction Grammar Approach
Name of researcher(s): Ben Ambridge, I Made Sena Darmasetiyawan

Please tick

1. I confirm that I have read and have understood the information sheet dated 14/09/20 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that taking part in the study involves rating Balinese sentences for grammatical acceptability. ☐
3. I understand that my participation is voluntary and that I am free to stop taking part and can withdraw from the study at any time prior to 28 days after the experiment without giving any reason and without my rights being affected. In addition, I understand that I am free to decline to answer any particular question or questions, but that compensation will be given only for completion of the full study, and that if I choose to quit before completing the study, no such compensation will be possible. ☐
4. I understand that I can ask for access to the information I provide and I can request the destruction of that information if I wish at any time prior to 28 days after participating (when the anonymous aggregated dataset will be created for publication). I understand that 28 days after participation I will no longer be able to request access to or withdrawal of the information I provide. ☐
5. I understand that the information I provide will be held securely and in line with data protection requirements at the University of Liverpool until it is aggregated into the anonymous dataset, and then deposited publicly on the website of the Open Science Framework. ☐
6. I understand that my consent form will be retained for 5 years and then securely shredded. ☐
7. I agree to take part in the above study. ☐

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UNIVERSITY OF LIVERPOOL

Committee on Research Ethics

Participant Information Sheet

Acquisition of Balinese Passives: A Construction Grammar Approach. Version 5.0. 14th of September 2020

You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with your friends, and relatives, if you wish. We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.

Thank you for reading this.

8. **What is the purpose of the study?**

The purpose of the study is to investigate a puzzle facing adults who are learning Balinese. Some verbs can appear in all of these different sentence types, i.e. man was called by woman; *Nak muani ento kakauk teken nak luh ento* or *Nak muani ento kauka teken nak luh ento*, but some verbs cannot, i.e. *Nak muani ento makauk teken nak luh ento,* since only *Nak muani ento makauk* is grammatically acceptable. We are trying to find out how adults learn this.

9. **Why have I been chosen to take part?**

Because you are a native speaker of Balinese language and over 18 years old. Overall, we need to recruit 60 adults If you're not a native speaker of Balinese, please don't take part.

10. **Do I have to take part?**

No - Participation is voluntary and participants are free to withdraw at any time prior to 28 days after the experiment without explanation and without incurring any disadvantage. In addition to obtaining consent, we will ask each participant if s/he wants to take part in the study. Any participant who does not want to take part, or who, having started, does not want to continue, will not be coerced into doing so.

11. **What will happen if I take part?**

You will take part in single session of approximately 40 minutes. You will be asked to watch an animation and rate the grammatical acceptability of each sentence by clicking on a 10-point scale. Your choices will be recorded automatically by the computer program. All we're recording is your clicks – no audio or video. We've come up with 250 of these sentences.

12. **How will my data be used?**

Your data will be anonymous from the point it is collected – we will not record your name. Once we've written up our study, we'll post all of the anonymous data on the website of the Open Science Framework (https://osf.io/). This is best practice because it allows other researchers to test their own theories using the data, and to check our working. (Legal note: Because this data is completely anonymous, it's not "personal data" as defined under the General Data Protection Regulation [GDPR]). Further information on how your data will be used can be found in the table below.

How will my data be collected?	Using an online platform, Gorilla.sc
How will my data be stored?	All sentence rating data will be stored electronically
How long will my data be stored for?	Indefinitely on the website of the Open Science Framework
What measures are in place to protect the security and confidentiality of my data?	No breach of confidentiality will be possible, since names are never stored
Will my data be anonymised?	Yes, no names are ever stored
How will my data be used?	The researchers will use the data to test theories of child language acquisition. Once the public dataset has been made available, anyone can use it for any lawful purpose
Who will have access to my data?	Initially, just the researchers; anyone after the dataset has been made public
Will my data be archived for use in other research projects in the future?	Yes, at https://osf.io/
How will my data be destroyed?	The anonymous data will be stored indefinitely. Consent forms will be securely shredded as soon as the public dataset has been published

13. **Expenses and / or payments**

    You will receive compensation of Rp.50.000,- to your phone credit top up.

14. **Are there any risks in taking part?**

    No – participants complete the study on their own computer in their own time, meaning that the study introduces no risks beyond those incurred in everyday internet browsing.

15. **Are there any benefits in taking part?**

    This study has no specific educational benefits, but participants do generally enjoy taking part and learning more about the Balinese language.

16. **What will happen to the results of the study?**

    They'll be published in an academic journal and presented at an academic conference. Remember, you won't be identifiable in any results, as you remain anonymous at all times. If you would like a copy of the journal article, or a plain language summary, please get in touch via the contact details in 10 below.

17. **What if I am unhappy or if there is a problem?**

    If you are unhappy, or if there is a problem, please feel free to let us know by contacting Prof Ben Ambridge (+44 151 794 1111 / Ben.Ambridge@liverpool.ac.uk) or the student researcher I Made Sena Darmasetiyawan (I.Made.Sena.Darmasetiyawan@liverpool.ac.uk) and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the Research Ethics and Integrity Office at ethics@liv.ac.uk. When contacting the Research Ethics and Integrity Office, please provide details of the name or description of the study (so that it can be identified), the researcher involved and the details of the complaint you wish to make. The University strives to maintain the highest standards of rigour in the processing of your data. However, if you

have any concerns about the way in which the University processes your personal data, it is important that you are aware of your right to lodge a complaint with the Information Commissioner's Office by calling 0303 123 1113.

18. **What will happen if I want to stop taking part?**

    You are free to withdraw at any time prior to 28 days after the experiment without explanation. After 28 days, we will aggregate the data into the public dataset, and no withdrawal will be possible. If you withdraw before the end of the study, we will delete all of your data. If you complete the study and then decide you want to withdraw and have us delete your data, contact us via the email address below, quoting the unique participant code that you will be given at the end of the study.

19. **Who can I contact if I have further questions?**

    The Principal Investigator: Ben Ambridge (+44 151 794 1111/

    Ben.Ambridge@liverpool.ac.uk***)* or the student researcher I Made Sena Darmasetiyawan**

    (I.Made.Sena.Darmasetiyawan@liverpool.ac.uk**)**

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i Although Pinker's proposal was originally developed in the lexicalist framework of Lexical Functional Grammar, it is compatible – perhaps even more compatible – with construction-based approaches. As Pinker (2013: xv) himself notes in the foreword to the most recent edition of Pinker (1989), his analysis is "upward compatible with…the various versions of Construction Grammar, such as those developed by Ronald Langacker, Adele Goldberg and William Croft. Indeed, my notion of the "thematic core" of an argument structure, which delineates the "conflation class" of verbs compatible with that argument structure, is very close to the idea of a "construction meaning" invoked by theories of construction grammar.

ii Erteschik-Shir (2006: 319) gives *"What did the paper editorialize that the minister had done*" as an example of a violation of an information-structure constraint (specifically that extraction cannot happen from backgrounded/presupposed constituents like "the minister had done X"); one that can be improved by context ([this] example…"would sound much better if uttered by a member of an editorial board".