Exploring the Relationship Between Socioeconomic Status, Language Exposure and Language Processing in Young Adults

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The candidate confirms that the work submitted is their own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

Socio-economic status (SES) has a strong influence on language development, including both vocabulary (e.g., Hart & Risley, 1995) and grammar development (e.g. Huttenlocher et al., 2002). SES influences on both language domains have been shown to be partially mediated by spoken and written language exposure (e.g. Fernald et al., 2013; Rowe, 2008). Fewer studies have examined the role of SES in other language domains, and particularly sentence processing. The goal of this research was to examine the influence of SES and cumulative differences in language exposure on skills supporting sentence comprehension and production. Crucially, these differences are explored in a sample of young adults. Two studies tested a newly developed set of measures which assessed written and spoken language exposure using measures adapted from previous studies (e.g., Acheson et al., 2008), including an updated version of the Author Recognition Test (ART; Moore & Gordon, 2015; Stanovich & West, 1989), and newly developed measures (e.g., measures of spoken language exposure, measures of sentence structure familiarity). Measures of objective SES (parental occupation, parental education, and household income) and subjective SES (MacArthur Scale of Subjective Social Status; Adler et al., 2000) were also included. To examine language use, measures were included to assess vocabulary knowledge, and language comprehension and production across domains (e.g., word-level, sentence-level, including standardized tests and real-time processing tasks). Measures of SES significantly predicted vocabulary knowledge but were not found to significantly relate to language exposure or other measures of language use. Language exposure significantly predicted vocabulary knowledge and passage comprehension and showed marginally significant results with online sentence comprehension and online sentence production, with recreational reading and the ART as significant predictors.

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List of Abbreviations

ART	Author Recognition Test
BNC	British National Corpus
CELF	Clinical Evaluations for Language Fundamentals
CRH	Comparative Reading Habits
EFA	Exploratory Factor Analysis
HSES	High Socio-economic Status
LEAP-Q	Language Experience and Proficiency Questionnaire
LexTALE	Lexical Test for Advanced Learners of English
LSES	Low Socio-economic Status
MRT	Magazine Recognition Test
ONS	Office for National Statistics
ORC	Object Relative Clause
OSV	Object-Subject-Verb
PPVT	Peabody Picture Vocabulary Test
PRC	Passive Relative Clause
RH	Reading Habits
RT	Reading Time
SES	Socio-economic Status
SRC	Subject Relative Clause
SSS	Subjective Social Status
SVO	Subject-Verb-Object
TOAL	Test of Adolescent and Adult Language
TROG	Test for Reception of Grammar
TRT	Title Recognition Test
UG	Universal Grammar
WAIS	Wechsler Adult Intelligence Scale
WASI	Wechsler Abbreviated Scale of Intelligence

Chapter 1: Literature Review

Learning a language is a complex task, which the majority of typically developing children accomplish in the early years of life. Children acquire and develop language at different rates, and it is finding the cause of this difference that is of interest to researchers. There are many competing theories of how this occurs. One big debate in the literature is to what extent different aspects of language are influenced by innate factors and environmental factors.

Research has investigated the roles of both genetics and the environment in the acquisition of language. A genetic influence includes any heritable traits of a child that influences their capability to learn and process language. An environmental influence incorporates the language that a child is exposed to within their environment, which can include multiple sources, such as child-directed speech from parents or caregivers, or access to reading materials (e.g. Rowe, 2008).

Noam Chomsky, one of the most influential linguists, made the claim that language is an innate ability (Chomsky & Halle, 1965). Chomsky proposed that every human is born with an internal framework of linguistic principles, namely Universal Grammar (UG), that allows for a child to acquire language. Within this theory, a child is exposed to the lexical items within a language, such as English, and embeds them within the framework of UG (Chomsky & Halle, 1965). This provides an explanation for how individuals learn different native languages, and how children produce unique grammatical sentences when they have only been exposed to some component parts. Due to an internalised rule-based grammar system, children can take the linguistic input from the environment and generalise to produce sentences they have not encountered previously (Saffran & Thiessen, 2007). This nativist perspective claims that input from

the environment is not sufficient to explain how children acquire a wealth of vocabulary and the ability to produce grammatical sentences in the first few years of life (Gathercole & Hoff, 2007). However, many researchers have challenged the proposal that there is an innate framework of language as suggested by Chomsky, proposing that a child's mind contains only the mechanisms for acquiring the rules for language, rather than containing pre-determined rules that fit every language (Hoff, 2006). This opposing view also has support from findings that children's developing language mostly reflects patterns of language in the input (e.g. Fernald & Marchman, 2006; Gathercole & Hoff, 2007; Saffran & Thiessen, 2007).

Moreover, to learn the rules of language, an environmental influence must be considered. Research has drawn from the bioecological model of development set out by Bronfenbrenner (1986). The model outlines different levels of social contexts that influence a child's environment. This includes proximal influences, which are relationships with family and peers, and distal influences, which have an indirect influence on an individual, such as socio-economic status (Pace, Luo, Hirsh-Pasek, & Golinkoff, 2017). Hoff (2006) suggests when combining these explanations of language development, it can be assumed that the mechanisms for acquiring the rules of language reside in the child's mind, while the child resides within the different levels of the social contexts in the environment.

Additionally, twin studies have demonstrated that genetic and environmental factors interact in language development. So, it may not be that a child's language development is caused by either genes or the environment, nature or nurture, but a combination of both in varying degrees. Dale, Tosto, Hayiou-Thomas, & Plomin (2015) showed that a combination of these two variables leads to a gene-environment correlation. Oliver, Dale and Plomin (2005) found that when conducting twin studies,

genetics alone showed a small significant contribution to literacy development, but when assessing for bivariate heritability, which is the combination of the contribution of genes alone and genes influencing the environment, it contributed up to one quarter of the correlation between the variables and the language outcome of the children. Thus, there is likely to be an interaction of genetics and the environment when developing language.

The following review will focus on the environmental influences on language development throughout childhood and adolescence. The first section will focus on socio-economic status (SES) and the relationship between SES and vocabulary development. Following this, focus will be on the environmental influences of grammar.

1.1 Socio-economic Status

1.1.1 Socioeconomic Status as a Construct

Socioeconomic status is an individual's place within the societal hierarchy in terms of their access to social, financial, and educational resources (Pace et al., 2017). Every society has individuals that are worse and better off because of their material and non-material resources, such as income or education. Those that have lower financial and educational resources are typically defined as having a low SES (LSES), and those that have higher financial resources and more education are typically defined as having a high SES (HSES). SES has been measured in children using many different variables, the most robust being family income, parental education, more specifically maternal education, parental occupation, and access to free school meals (e.g. Betancourt, Brodsky, & Hurt, 2015). While it may be a sensitive measure of current living standards, family income is subject to change more frequently than factors such as

parental education and occupation, therefore, family income can be considered as somewhat of a snapshot measure of SES, rather than an indication of long-term SES (Duncan & Magnuson, 2003). Other variables that are not predictors but show covariance with SES include material resources, parent-child interaction, child-directed speech, and exposure to violence and toxins (Hackman & Farah, 2009; Hackman, Farah, & Meaney, 2010; Johnson, Riis, & Noble, 2016). While each measure can indicate, but not substantiate an individual's SES, a combination of variables may give a more robust indication (Entwislea & Astone, 1994). This is due to the inter-related nature of each variable; for example, family income usually increases with advanced education or a highly skilled occupation and therefore, can increase access to material resources, while education also influences the type of occupation and the level of parent-child interaction. SES, as a combination of these indicators, has support from previous research indicating an influence on a child's physical health, emotional resilience, cognitive and neural development, and educational progression (see Hoff, 2013, for a review).

1.1.2 Socioeconomic Status and Neural Development

SES has an influence on many aspects of a child's life, with children from LSES backgrounds showing on average lower cognitive ability and educational progression than children from HSES backgrounds (see Hackman & Farah, 2009, for a review). Research has shown SES disparities in neural structure as well as neural activation influences cognitive processing in areas such as language processing, executive functioning, including inhibition and working memory, and emotion (see Hackman & Farah, 2009, for a review). For example, Sheridan, Sarsour, Jutte, D'Esposito and Boyce

(2012) found that HSES children showed an increased activation in prefrontal and parietal cortices as working memory load increased, compared to LSES children.

As it has been shown that children from LSES backgrounds receive less cognitive stimulation, fewer learning materials, and hear less complex language and less language generally than children from high HSES backgrounds, this limits the rich sensory data that is necessary for normal neural development. Rosen et al. (2018) showed an association between cognitive stimulation in the home and thickness of cortical structure. It was found that the LSES group, which experienced less cognitive stimulation in the home, had thinner cortical structure in the frontoparietal regions, and less neural activation in the prefrontal and occipital-temporal cortices during working memory tasks.

In a study on the role of environmental factors in neural development of language areas, Romeo et al. (2018) measured conversational turns between parents and children aged four to six years of age from a range of SES backgrounds, as well as measuring neural activation while listening to short stories. The results showed that language experience, as measured by the conversational turns, mediated the relationship between SES and verbal ability of the children. This shows that it is not simply the amount of language the child hears, but how often the children have a chance to interact with language by engaging in conversation. Additionally, neural activity showed an increase in activation in the key language area, Broca's area, during language processing in children who had more conversational turns when interacting with parents (Romeo et al., 2018). Both activation of Broca's area and conversational turns mediated the relationship between SES and children's language ability.

Studies measuring neural activity and cognitive ability in adults are much less consistent compared to studies with children. For example, there is research which

consistently shows differences in hippocampal volume between HSES and LSES children (see Farah, 2017, for review). However similar research in young adults is less consistent, with some studies failing to show an SES-related difference in hippocampal volume (e.g. Yu et al., 2018). This could suggest that SES-related disparities in cognitive development may be reduced by adulthood.

1.1.3 Socioeconomic status and Environmental Factors

It is important to understand that the influence of SES on language development is underpinned by many different environmental factors (Petrill, Pike, Price, & Plomin, 2004). Some of these factors include nutrition, crowding, parental responsiveness, birth order, sibling quantity, and educational stimulation. Pace et al. (2017) suggest that one mediator of SES and language ability is the richness of the environments that the child is exposed to. This can include the availability of reading and learning resources in the home, and the opportunities that the child is given to learn outside the home, such as visiting the library. The second mediator is the proximal interactions a child is exposed to, including the quantity and quality of parent interactions with the child. The family environment has a large influence in the first years of life, with parents and other family members being the primary source of language input in the early period of language learning (Buac, Gross, & Kaushanskaya, 2014).

Most child-directed speech typically occurs within the home environment in the earliest years of life. Rowe (2008) found that children's vocabulary size can be predicted by quantitative properties of child-directed speech, including number of word tokens, length of utterance and directive speech, and word type used by parents. This result supports previous research, which also found that number of word tokens, mean length of utterance and number of word types were predictive of children's vocabulary

(Hoff, 2003). Therefore, these findings have important implications for children's future language use and understanding (Rowe, 2008). For example, research has supported the finding that vocabulary size at age three is correlated with educational achievement at age nine or ten (Hoff, 2003), showing that experience in the early years may be a crucial time for language development, as it has been shown to relate to future educational abilities.

Child-directed speech has also been shown to be used in different ways. HSES parents are more likely to create lengthy conversations with children and use child-directed speech for praise and encouragement (Hart & Risley, 2003), whereas LSES parents are more likely to use this for directing or discouraging certain behaviours in children (Rowe, 2008). In a previous longitudinal study by Hart and Risley (1999), it was found that affirmative feedback was given to children more than 30 times per hour in HSES families, 15 times per hour by working class parents, and only 6 times per hour by LSES parents. This result was found to affect a child's language development between 18 months and 6 years old and it is suggested that this finding is due to mother-child interaction and is found regardless of their SES level (Olson, Bates, & Kaskie, 1992).

In terms of language development, specifically, two accounts have been put forward to explain the differences in language input between SES groups. The first is a difference in knowledge and beliefs about language development. It has been shown that SES relates to parent beliefs and parenting practices (Rowe, 2008). Knowledge about child development will influence the type of interaction parents have with their children. Cross cultural studies have found that mothers from western societies will often elicit conversation with children by asking children questions about different objects or events, whereas mothers in countries such as Kenya only communicate with

children if they are in distress, believing that children will acquire language on their own (Richman, Miller, & LeVine, 1992). Johnston and Wong (2002) found differences in parent-child interaction between Western and Chinese families, such as Chinese parents do not allow their children to talk with adults who are not family members. However, Chinese parents take more of an instructional approach to children's learning, compared to a more learning through play approach that Western parents take. Behavioural observations of Bolivian Tsimane communities revealed that adults engage in child-directed speech for approximately less than one minute per daylight hour (Cristia, Dupoux, Gurven, & Stieglitz, 2019). Additionally, Schneidman and Goldin-Meadow (2012) studied the amount of child-directed language input Mayan children receive, compared to children from the United States. Mayan children typically heard less child-directed speech, and fewer utterances in total compared to US children, which meant that most of the language exposure was due to overhearing speech from others. This significantly smaller proportion of child-directed speech impacted on children's later vocabulary knowledge (Shneidman & Goldin-Meadow, 2012).

In Rowe's (2008) study, it was found that parent knowledge mediated the relationship between SES and child-directed speech. Therefore, if parent knowledge and belief does not hold importance to child-directed speech and communication, this impacts the language learning of the child, resulting in children falling behind their peers in their language development.

A second explanation may be the verbal abilities of parents and how this affects language use during child directed speech, which may also be influenced by parental education, representing a gene-environment correlation. Parents from HSES backgrounds may use more advanced vocabulary during child-directed speech, based on their experiences with language, than LSES parents (Rowe, 2008). Maternal

language has been found to significantly predict parent-child shared storybook reading in the home, which is an important part of the language input (Puglisi, Hulme, Hamilton, & Snowling, 2017).

1.1.4 Socioeconomic status and vocabulary development in the early years

The focus here will be on vocabulary knowledge, and how this differs between HSES and LSES groups. Vocabulary is an important aspect of language development as it lays the foundations for acquiring further language skills, such as creating multiword sequences and grammatical processing (Pace, Alper, Burchinal, Golinkoff, & Hirsh-Pasek, 2019). As parents or caregivers are the primary source of input in the first years of life, it is important to understand how different types of input and level of input, which differs between LSES and HSES groups, create differences in vocabulary development.

It is well established in the literature that SES is related to language outcomes, specifically vocabulary. Parent-child interaction, encompassing child-directed speech, has been widely researched in relation to language development (see Hoff, 2006, for review). Parents from HSES families produce more child-directed speech than parents from LSES families. Hart and Risley's (2003) study showed a substantial difference in the amount of child-directed speech heard by children. Throughout the course of the study, children from HSES backgrounds heard 2153 words per hour, compared to just 616 words heard by LSES children. The results showed that by age 3, on average, there is a word-gap of 32 million words heard by high- and low-SES children. Consequently, this will have a strong influence on a child's vocabulary development in the early years. Another important finding was that up to 98% of vocabulary recorded in the child's language also appeared in parent's language (Hart & Risley, 2003), showing that

parent's language has a strong impact on a child's vocabulary development. However, the study by Hart and Risley (2003) has been criticised for overestimating the size of the gap, basing the results on a relatively small sample of 42 families. A more recent study replicated the Hart and Risley (2003) study by recording 49,765 hours of natural language in family homes over the course of six to 38 months (Gilkerson et al., 2017). This study found an average word-gap of only four million words heard by HSES and LSES children by four years old, with HSES children hearing approximately 3000 more words per day than LSES children. This is still a substantial difference in the number of words heard between HSES and LSES children, yet not as large as Hart and Risley's (2003) claim.

Weisleder and Fernald (2013) were interested to look at whether language experience in the early years could predict language processing at 1.5 to 2 years of age. In the study, language was recorded in the home for a period of six days, and proportion of looking to a target picture after hearing a sentence was tested to measure language processing. It was found that amount of child-directed speech significantly correlated with efficiency of language processing, showing that the more child-directed speech heard, the more efficient a child's processing of familiar words in real time. This result was also present when controlling for vocabulary size at 24 months. Weisleder and Fernald (2013) conclude that in addition to the number and complexity of words heard, efficient language processing also mediates the effect of child-directed speech on vocabulary development; children who are exposed to more child-directed speech, have more opportunity to learn and use language, and as a result learn new words faster, aiding vocabulary development.

In summary, parental language input plays an important role in the development of a child's language in the early years. The language input experienced in the home

can lay foundations for language development as children progress through education. Research often references the Matthew Effect when discussing language development (Stanovich, 1986). This is the idea that those that have a larger vocabulary and more reading experience when starting formal schooling will read more and continue to learn language more quickly in school, and therefore use this prior experience to their advantage. Conversely, those that have less experience with reading and smaller vocabularies will develop vocabularies more slowly, read less and possibly enjoy reading less (Stanovich, 1986). Duff, Tomblin and Catts (2015) showed support for the Matthew Effect for both vocabulary and word reading skill. Strong readers increased their vocabulary knowledge compared to weak readers. This shows how important early language input is to vocabulary development.

The home environment contains many variables which can influence a child's language development, child-directed speech being only a single variable. The relationship between vocabulary development and SES may also be mediated by another type of linguistic input - shared book reading (Rowe, 2012). Shared book reading is a situation in which parents read a storybook to their children, both before and after their children learn to read (Hindman, Connor, Jewkes, & Morrison, 2008). This can help both vocabulary and reading development before formal education. Shared reading can help build vocabulary knowledge in children, which provides the foundations for more complex language learning in later life (see Mol, Bus, de Jong, & Smeets, 2008, for review). During shared book reading, parents often engage in conversation with their child about the book, as well as reading the text (Mol et al., 2008). This gives the child experience with both vocabulary presented in the book and in conversation, which has been found to differ (Montag & MacDonald, 2015; Roland, Dick, & Elman, 2007). It has been found that during shared reading, parents' language

contains more diverse vocabulary than language used at times other than during shared reading (Ece Demir-Lira, Applebaum, Goldin-Meadow, & Levine, 2019).

In a study comparing the language in children's picture books and child-directed speech, Montag et al. (2015) found that picture books, aimed at young children unable to read and therefore require shared book reading by a parent, included a more diverse vocabulary range than child-directed speech. The analysis of the picture book and child-directed speech corpora showed that there were 1.72 times more unique words in picture books. The authors suggest that this is due to child-directed speech usually being constrained by here-and-now context, whereas books can cover a range of contexts (Montag & MacDonald, 2015).

A set of studies have also investigated the event of shared book reading with wordless books and how this influences children's language (Arizpe, 2013; Beckett, 2013; Ramos & Ramos, 2011). When reading a wordless picture book, the reader must verbalise what happens in the story based on the pictures, and therefore it is more likely that the child will actively participate in this activity (Arizpe, 2013). One such study by Chaparro-Moreno, Reali, and Maldonado-Carreño (2017) compared how pre-school children and teachers interact when reading typical storybooks and wordless picture books. Half of the participants read typical storybooks that included words, and the other half read wordless picture books. Book reading sessions were recorded, and interactions were analysed. The authors found that children produced more diverse language when reading wordless picture books, with teachers giving more instructional support.

Although this method can provide positive outcomes and more active participation from the child than shared book reading, a wordless picture book does not provide the more complex words and structures found in typical books. The study cited

earlier by Chaparro-Moreno et al. (2017), investigated children's spontaneous language when reading, and so does not compare the development of vocabulary when reading typical books compared to picture books. The authors did, however, find that even though teachers tended to mirror the sentence structures in the books whilst talking to the child, more diverse structures were found when teachers were discussing the picture books (Chaparro-Moreno et al., 2017).

This range of vocabulary input in the event of shared book reading is important for developing language processing of different types of sentences. Children who experience less shared book reading, have less opportunity to benefit from conversation between parents and children during shared book reading, as this is a good opportunity for enhancing language (Sénéchal, Pagan, Lever, & Ouellette, 2008). Sénéchal et al. (2008) also suggest that books in the home can be read more than once, and therefore, re-reading books can increase exposure to the syntactically complex words and sentences within them. Horst, Parsons and Bryan (2011) examined whether reading a book more than once improved word learning in children. Manipulating the words children are exposed to during shared book reading, and testing recall and retention of new words, the study found that children are better at recalling and retaining new words if they are exposed to them multiple times. Therefore, reading the same book more than once can facilitate language learning in children.

Marjanovič-Umek, Fekonja-Peklaj and Sočan (2017) measured young children's vocabulary and grammar skills over a period of 15 months, from 1.5 to 2.5 years, and found that parental education, an index of SES, predicted frequency of shared book reading. Higher educated parents read books with their children more frequently than less educated parents. Additionally, frequency of shared book reading mediated the effect of parental education on vocabulary and grammar skill.

Furthermore, it is well understood that frequency of exposure to storybooks is an important aspect of development of more complex language (Sénéchal et al., 2008). For example, passive sentences are more likely to be found in written language rather than spoken language (Roland et al., 2007). English has a standard word order of subject-verb-object (Akhtar, 1999). Therefore, a typical sentence would follow the subject-verb-object word order, such as the 'the boy helped the girl'. Conversely, a sentence that does not follow this would be atypical, such as 'the girl the boy helped' which has a word order of object-subject-verb. More complex sentences, specified as those with an atypical object before subject word order, are found more often in written language than spoken language (Roland et al., 2007). In Sénéchal et al.'s (2008) study, it was found that shared book reading was correlated with comprehension of syntactically complex sentences. Yet when further analysis was performed, an interesting result was found which showed shared reading did not predict comprehension of complex sentences, but parental literacy did. One explanation given by the authors is that, as stated above, the conversation likely to take place during shared book reading may influence comprehension of complex structures more than the book reading itself; and therefore, difference in parental literacy will influence how much this is affected.

1.1.5 Summary

To summarise, SES is an important predictor of language development in childhood and throughout the course of formal education, and much research supports this claim (e.g. Buac et al., 2014; Hart & Risley, 2003; Hoff, 2006; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Marchman & Fernald, 2008). The relationship between SES

and language development has been shown to be mediated by several factors, such as parent-child interaction and shared book reading. This review has discussed the impact of SES on the growth of vocabulary specifically. However, only a handful of studies have investigated the influence of SES and language input on more complex linguistic skills, such as sentence comprehension and production. These are key skills underlying complex language usage which are particularly important in later linguistic development, and specifically for developing academic literacy (e.g. Snow, 2014). The following sections will outline theories concerning individual differences in sentence processing, with focus on more complex language, and how SES may influence this.

1.2 Sentence processing

The following section provides an overview of the role of the linguistic environment in language processing, particularly for processing of complex sentence structures.

1.2.1 Processing of Relative Clauses

In the sentence processing literature, some focus has been on the ability to process different types of syntactic structures, and why some structures are more difficult to process than others (e.g. Wells, Christiansen, Race, Acheson, & MacDonald, 2009). One type of complex sentence structure that is prevalent in the literature is relative clauses (Wells et al., 2009). Relative clauses are subordinate clauses that typically modify a preceding noun or noun phrase. To illustrate this, the relative clause in sentence (1a) below *that trained the typist* further modifies the preceding noun phrase *the clerk*. The difference between a subject relative clause (SRC), as in (1a) below, and an object relative clause (ORC) in (1b) lies in the position of the noun, and whether it

is the subject, or the object of the action being produced. An SRC is a structure in which the head noun (e.g. *clerk* in sentence (1a) below) is the agent performing the action in both the main clause *told the truth*, and the relative clause *that trained the typist*. The harder ORC is a structure in which the head noun is both an agent (subject) and an object: the object of the action *trained* in the relative clause, but the agent of the main clause *told the truth* (Wells et al., 2009).

(1a) Subject relative: *The clerk that trained the typist told the truth.*

(1b) Object relative: *The clerk that the typist trained told the truth.*

It is well established in the literature that SRCs are easier to process than ORCs, however, there is little agreement concerning what makes the processing of an ORC harder than an SRC (e.g. Wells et al., 2009). There are two main theories that have been put forward to explain this. The first theory suggests that difficulty with comprehending ORCs is due to their syntactic complexity and the memory demands needed for interpretation (Just & Carpenter, 1992). Due to the structure of an ORC sentence, the head noun of the relative clause must be retained in memory until the action is known, unlike in a SRC. Taking the examples from Montag and MacDonald (2015), in the ORC (1b), the head noun *clerk* must be retained in memory until the action *trained* is known, unlike the SRC (1a), in which *trained* immediately follows the head noun. Montgomery and Evans (2009) suggest that difficulty with ORCs is due to difficulty in assigning thematic roles to the two nouns (e.g. subject and object, who is doing what to whom). If both nouns are animate, then it must be understood that even though the first noun, e.g. *clerk*, is in the position of the subject, it is actually the object of the verb *trained*.

Therefore, after the verb, the sentence must be revisited due to temporary ambiguity (Montgomery & Evans, 2009).

A study by Chipere (2001) showed how memory training can increase recall of complex noun phrases. In this study, two groups of participants (low academic ability and high academic ability) were given memory training and comprehension training on a set of ten complex noun phrases. Participants were tested on their recall and comprehension of the noun phrases before and after the training. The results showed that memory training increased recall of sentences in low academic ability groups, so that after the study, there was no significant difference between this group and the high academic ability group. However, the memory training did not improve the comprehension of these sentences in either group. The author indicates that this does not fit with the working memory theory set out by Just and Carpenter (1992), which suggests that the ability to comprehend complex sentences is because of greater working memory capacities, and therefore, training working memory would increase this capacity to understand complex sentences. This could suggest that ability to comprehend complex sentences is due to factors other than memory. Another explanation could be how much exposure an individual has had to a complex sentence structure, as set out in the second theory below.

The second theory, the experience-based approach, suggests that an individual's ability to understand ORCs is based on their prior experience with these more complex sentences (MacDonald & Christiansen, 2002; Montag & MacDonald, 2015; Wells et al., 2009). As mentioned previously, English has a typical word order of subject-verb-object (Akhtar, 1999). Considering ORCs do not follow the typical subject-verb-object word order, but present an object first word order, individuals are less likely to predict the next word in the sentence, which creates temporary ambiguity (Grodner & Gibson,

2005). For example, in (1b), *The clerk* is initially assumed to be the subject of the sentence, as this would follow the typical word order, and therefore, the ambiguity arises when the reader gets to the actual subject of the sentence, the *typist*. At the presentation of the second noun, it is realised that the sentence does not follow the typical word order, and may need to be reanalysed, and this reanalysis has been found to increase reading time for ORCs (Gordon, Hendrick, & Johnson, 2001).

Wells et al. (2009) proposed that an individual's experience with different sentence structures might influence how quickly the ambiguity in ORCs might be resolved. Wells et al. (2009) based their hypothesis on a model of word reading. They tested this hypothesis by manipulating an individual's experience with those structures. Based on the Frequency X Regularity interaction model (MacDonald & Christiansen, 2002), an individual's ability to comprehend a written word is based on (1) that particular word's frequency of use in prior learning experience, and (2) how regular the spelling of that word is based on the rules of the language. Highly regular words will have a high number of words that have similar spellings, and the processing of that word will be helped by the other regularly spelled words. Irregular words, however, have fewer words that are spelled in the same way, and thus processing these words will not have the benefit of many other similarly spelled words (MacDonald & Christiansen, 2002). Therefore, if a word is highly frequent in the language and regularly spelled, then it should be very easy to process. However, an irregular word can still be more easily processed, if it is highly frequent in the language (Wells et al., 2009). For example, as explained in Wells et al. (2009), the letter sequence *int* is a good example of this, as it has two different pronunciations. The words *mint* and *pint* both end in the letter sequence *int* but are pronounced in different ways. The processing speed and accuracy of these two words depends on both the frequency of that word in

the language, and how many other similarly spelled words have the same pronunciation. Therefore, *mint* may be processed faster due to other words such as *hint, sprint, lint* etc. The irregular word *pint* has fewer "neighbours" and so this would make its processing speed and accuracy more difficult, however this can be compensated by its own high frequency.

Wells et al. (2009) based their hypothesis of sentence comprehension on this model and suggested that an individual's ability to understand a sentence is based on the frequency and regularity of that sentence structure. Relative clauses are a good example of this assumption. SRCs share the dominant subject-verb-object word order of English sentences (e.g. Roland et al., 2007). Therefore, SRCs are likely to be processed faster because an individual will have more experience of the typical, "regular", word order of the language to draw from when reading the sentence. Conversely, ORCs have a less typical object-subject-verb word order and will have fewer sentences in the language that also follow this word order (i.e. fewer "neighbours"). Therefore, how quickly an ORC is processed will be more dependent on how frequent this specific structure is in an individual's experience (Wells et al., 2009). If ORCs are highly frequent in the language an individual is exposed to, the sentence will be processed faster due to more experience with this sentence type, compared to an individual that has less experience with ORCs.

In the Wells et al. (2009) study, participants were split into an experience group and a control group. The experience group received experience with both SRCs and ORCs, while the control group received experience with other sentence structures, including sentential complements and conjoined sentences, but not with either type of relative clause. Comprehension of SRCs and ORCs was tested in both groups before and after the experience manipulation.

The results supported the authors' predictions, in that reading time at the main verb changed for the experience group after experience with relative clauses. The main verb is a key aspect of the sentence as it immediately follows the relative clause, and it is the key region for the integration of information between the main clause and the relative clause. The reading time at the main verb decreased for ORCs making it similar to the reading time for SRCs, but there was little change in the control group (Wells et al., 2009). Thus, experience had a greater effect on ORCs than SRCs, which suggests that participants benefitted from their experience with ORCs. The authors did not expect the experience to influence SRCs due to the structure following the word order of the majority of sentences in the English language. As subject-first sentences are highly frequent in the language, any additional experience with the structure in this study was not expected to influence reading time for SRCs. In terms of accuracy, there was an effect of relative clause type but not experience group. The results thus support the view that experience plays an important role in comprehension of relative clauses.

1.2.2 Sentence Processing and Statistical Learning Theories

One way that experience plays a role in the development of complex sentence processing is through statistical learning. Statistical learning is the ability to implicitly learn patterns in the environment (Romberg & Saffran, 2010). In language, it is thought that due to the regularities within a language system, and the statistical probabilities of one syllable occurring after another, or one word occurring after another, children are able to learn language from recognising the statistical regularities that occur (Saffran, 2003). Statistical cues within language, such as word boundaries and syllable patterns, allow individuals to learn and recognise the meaning of sentence structures, even if the speech stream is interrupted (Conway, Bauernschmidt, Huang, & Pisoni, 2010).

Statistical learning is used to acquire linguistic knowledge in the early years and throughout the lifespan, from segmenting the continuous speech stream and identifying word boundaries (e.g. Saffran, Aslin, & Newport, 1996), through learning non-adjacent dependencies (e.g. Gomez, 2002), to sentence-level regularities (e.g. Misyak, Christiansen, & Tomblin, 2010; Seidenberg & MacDonald, 2018; Spencer, Kaschak, Jones, & Lonigan, 2015). This finding has been reported using several different paradigms of statistical learning, including artificial language and word boundary learning.

Word boundaries are recognised in the speech stream from the probability of different syllables occurring together (Saffran et al., 1996). The syllables within a word are more likely to occur together than the syllables between words. To illustrate this, in the speech stream *pretty baby*, it is more frequent to hear the syllables *pre* and *tty* together than *tty* and *ba* (Saffran & Thiessen, 2007). This type of information is used both by infants and adults to identify individual words in the speech stream (e.g. Saffran et al., 1996).

Statistical learning is usually assessed using artificial languages, in which individuals are asked to identify syllable pairs from a speech stream made up of several different artificial 'words' (Spencer et al., 2015). For example, Gómez (2002) assessed statistical learning of non-adjacent dependencies in children and adults, which involve learning statistical regularities of words that are not directly neighbouring in a sentence. To give an example in natural language, in the sentence *the books on the shelf are old*, the reader must recognise that the verb form *are* is used because of the plural form *book*s, even though *books* occurs much earlier in the sentence. Within the study by Gómez (2002), participants were asked to listen to a speech stream made up of artificial words. The speech stream was split into strings of three words, where the first and last

word always occurred in the same word string, with a mixture of other artificial words serving as the second word. For example, in the word string *pel-wadim-rud, rud* would follow *pel* the majority of times, to make it statistically more frequent than other combinations, with a range of words appearing in the centre position (Gomez, 2002). There were three artificial words that always appeared as the first word in the string, and three words that always appeared as the last word. In the centre position of the string, there were 24 different artificial words. Therefore, based on the assumption that learning the rules of a language is due to recognising patterns, one should learn that the first and third word occurring together is statistically more regular than the first and second word occurring together. Participants were required to indicate whether sentences heard in the test phase were the same as those heard in the speech stream, with the target words being the more frequent first and last words.

The results showed that both infants and adult participants could isolate particular word strings from other non-words using statistical regularities. The number of correct word strings identified increased as the number of words between the first and last word in the sequence increased. Therefore, the more variability in the middle words, the more the regularity of the co-occurrence of the first and the third element had a stronger effect. This shows that the more exposure to statistical regularities, even in an artificial language, the more likely an individual is to recognise the sequence of syllables occurring together. As mentioned in Spencer et al. (2015), an advantage of this task is that the only cue to the non-adjacent regularities of artificial words within speech streams is the statistical regularities between words. As an artificial language is used, there are no predetermined cues available for participants to utilise, therefore participants must rely on the regularity of two artificial ‘words’ occurring together to learn the non-adjacent dependencies.

Also using an artificial grammar design similar to Gómez (2002), Misyak et al. (2010) conducted three experiments investigating statistical learning, two of which will be discussed further. The first experiment, using the same materials as Gómez (2002), required participants to listen to a speech stream of artificial words, and then complete a task in which the artificial words were presented on the screen, and the participants' task was to click on the words as they were spoken. If participants had extracted the statistical regularities from the speech stream, they should be able to anticipate the last word in the string when conducting the task and be faster to click on it as the learning progresses (Misyak et al., 2010). The results showed that participants were successful at predicting the last word in the string in approximately 60% of the trials, thus confirming that they had extracted the statistical regularities.

The second experiment by Misyak et al. (2010) incorporated the use of relative clauses in the artificial grammar task. ORCs are more difficult to comprehend as they involve non-adjacent dependencies (Misyak et al., 2010), in that the main elements, the head noun and the embedded verb, are separated in the sentence. For example, in the sentence containing an ORC *the reporter that the senator attacked admitted the error*, the head noun *reporter* and the embedded verb *attacked* are separated by the second noun *senator*. In the SRC structure *the reporter that attacked the senator admitted the error*, the embedded verb is immediately follows the head noun.

The previous experiment in this study showed statistical learning in artificial words. This artificial language task reflects real language as more experience with different sentence structures reinforces the regularities of different types of words in different positions within the structure of the sentence. For example, increased exposure to SRCs which follow a subject-verb-object structure, will reinforce the likelihood of the subject appearing first, followed by a verb, then the object of the sentence. As there

is a reduced number of ORCs in written language, compared to SRCs (Roland et al., 2007), these types of sentences are less likely to be encountered more than others. Therefore, it could be that if individuals are less likely to encounter an ORC, this may affect the ability to reinforce the statistical regularities of this type of sentence.

In the second Misyak et al. (2010) study, participants were required to read a range of sentences containing ORCs, taken from Wells et al. (2009), and then answer a comprehension question based on the sentence. Sentences were presented in a self-paced reading task and reading times were recorded.

The results of the study found that comprehension rates for sentences were high in general, and rates for ORCs were lower than that of SRCs, which is consistent with previous research (e.g. Wells et al., 2009). Participants were grouped as having high or low statistical learning skill based on their prediction ability in the first task. It was found that those in the high statistical learning group were faster at reading ORCs, but only at the main verb. The main verb is the word that occurs immediately after the relative clause. This is the point at which readers may have to go back and reread the relative clause if they have assigned the nouns incorrectly by assuming the sentence would follow the regular word order. Therefore, if an individual has learned the statistical regularities of more complex ORCs, they will read the main verb faster due to correctly assigning the noun in the relative clause. This demonstrates that the ability to learn linguistic statistical regularities was related to the ability to comprehend less regular sentence structures such as ORCs. The authors' conclusions of this study, along with previous studies (e.g. Wells et al., 2009), provides evidence that statistical learning has an important and unique contribution to sentence processing (Misyak et al., 2010).

1.2.3 Sentence Processing, Relative Clauses, and Written Language Exposure

In the previous section, an experience-based statistical learning approach to sentence comprehension was described. The key studies illustrated how statistical learning in artificial languages may be related to the comprehension of complex syntactic structures. This section will describe how specific experience with natural language (e.g., through exposure with written language) might further influence sentence processing in language production.

In order to test these theories of sentence processing, and the effect of reading experience on relative clause use, Montag and MacDonald (2015) studied children and adults' ability to produce different types of complex structures, and whether this was related to language exposure.

The study by Montag and MacDonald (2015) examined whether differences in the types of sentence structures present in written compared to spoken language relates to differences in exposure to these structures, which may influence the ability to produce them. Specific focus was given to passive relative clauses (PRCs) and active ORCs, such as in (2a) and (2b).

(2a) Passive Relative: *The boy being kicked by the girl is wearing red shorts.*

(2b) Active Object Relative: *The boy the girl is kicking is wearing red shorts.*

Corpus analyses were conducted on PRCs and ORCs in child-directed speech (spoken language) and child literature (written language). The results showed relative clauses were higher in general in written language compared to spoken language, and specifically PRCs were higher in written language compared to ORCs. The author's hypothesised that as PRCs are more common in child and adult written language,

individual differences in text exposure should relate to PRC production in both children and adults.

In the Montag and Macdonald (2015) study, participants' text exposure was measured using the Author Recognition Test (ART, Stanovich & West, 1989) for adults and the Title Recognition Test (TRT, Cunningham & Stanovich, 1990) for children. Participants were then tested on their ability to produce relative clauses when describing an action in a static picture. Each static picture was presented in colour and included more than one action taking place. The authors identified 18 verbs that could describe both an animate and inanimate object, which were then represented in the pictures, once acting upon an animate object and once upon an inanimate object. An example used in the study is the verb *throw*; the picture representing this verb would be a ball being thrown (inanimate) and a man being thrown (animate, Gennari, Mirković, & MacDonald, 2012; Montag & MacDonald, 2015).

During the experiment, pre-recorded spoken questions were asked of participants that were presented in a way that would require the participant to produce a relative clause. For example, if the question asked 'What is orange?', participants would have to differentiate between the different objects in the picture, therefore producing a relative clause (Gennari et al., 2012; Montag & MacDonald, 2015). An example passive relative clause (PRC) would be *the ball being thrown by the man is orange*, or alternatively, an example active ORC would be *the ball the man is throwing is orange*.

When linked to the findings from the corpus analysis explored in the same study, the results showed that amount of text exposure affected production choices: individuals with more text exposure produced sentences similar to those found in written text (Montag & MacDonald, 2015). Specifically, individuals with more text

exposure produced more passive relative clauses, such as *the ball that was thrown by the man*, consistent with the results of the text-based corpus. The results also showed that active ORCs were produced more frequently in younger participants and individuals with less text exposure (Montag & MacDonald, 2015). This result is unusual and does not align with previous theories concerning syntactic complexity, in which children are less likely to produce ORCs because of the complexity of the construct and the memory demands needed to produce it (Montag & MacDonald, 2015). The authors do suggest, however, that this result supports the experience-based approach. Given that the results of the corpus analysis showed that children encounter more ORCs in speech than in text, children are more likely to produce active ORCs than passive relative clauses (PRCs) in this task, due to previous speech-based experience. To support this, the results from Roland et al.'s (2007) corpus study showed that ORCs are more frequent in spoken language compared to written language.

The overall findings suggest that younger individuals, with less text exposure compared to speech input, produce utterances similar to those found in the speech-based corpus. This would suggest that children are making production choices based on what they hear, due to having less text exposure than adults, whereas adults were shown to produce sentences that are most frequently found in text.

1.2.4 The Role of SES in Sentence Processing

As has been previously mentioned, studies have found HSES children produce more complex language than LSES children, in terms of complexity of words and sentence structures (Huttenlocher et al., 2010), and this is relative to the complexity of the input received.

The relationship between SES and processing of complex sentences has not yet been investigated fully. To date, only a handful of studies have explored SES differences in online processing of complex structures. Huang, Leech and Rowe (2017) aimed to adopt finer grained measures of syntactic development, specifically with the active-passive alternation within English, to investigate how development of online sentence processing differs between SES groups. The active-passive alternation was chosen because a single sentence can take on both an active and passive form and have the same meaning. For example, the active sentence *the cat was chasing the mouse* has the same meaning as the passive sentence *the mouse was being chased by the cat*.

It has been found in research that the passive form is harder to comprehend than the active form of a sentence (Huang, Leech, & Rowe, 2017). For this reason, comparing these structures is very informative when investigating comprehension of different sentence structures. The authors based their hypotheses on two main approaches to individual differences in processing these structures: a knowledge-based and a real-time processing approach. The knowledge-based approach assumes that it is an individual's experience, and therefore knowledge, with active and passive structures that influences their ability to comprehend that structure. As an individual develops, they are likely to have more experience with passives, than in childhood.

A second theory that explains difficulty with passives where the experience theory cannot, suggests that difficulty is more likely due to real-time processing of the passive structure (Huang, Zheng, Meng, & Snedeker, 2013). This theory suggests that due to passives following the less frequent object-first word order, passives are ambiguous until after the verb, therefore, misinterpretation will require the reader to go back and review the sentence after knowing the verb, to be able to fully understand the meaning. For example, in the sentence *the seal is quickly eaten by the fish*, ambiguity

arises when the reader gets to the verb *eaten* due to the first noun being assumed to be the subject of the sentence, or the one performing the action. In the active sentence *the seal is quickly eating the fish*, the first noun is the subject, and so the sentence does not need to be reinterpreted. Therefore, misinterpretation is likely to occur more often when reading a passive structure than an active structure.

In an active sentence, the head noun is the agent performing the action that the verb describes, such as '*the seal is eating the fish'*, whereas in a passive sentence, the head noun is the object of another agent performing an action, such as '*the seal is eaten by the shark*' (Huang et al., 2017). Passive sentences are more likely to be re-evaluated from the onset of the verb, and therefore comprehending the sentence is harder and slower. The study by Huang et al. (2017) showed how children aged five to seven years old are less accurate at comprehending passives that need re-evaluated, especially those from LSES backgrounds. This supports the theory that some sentences, such as passives and ORCs, are more syntactically complex and ultimately harder to comprehend and produce. However, as the study focuses on differences of comprehension ability between SES groups, the results suggest an experience-based explanation of SES differences. The authors indicate that one possible explanation is the availability of specific language experiences to learn these complex structures (Huang et al., 2017), which could imply that with sufficient experience, individuals could comprehend more complex sentence structures.

To investigate differences in language comprehension between SES groups, comprehension of active and passive structures was investigated in children aged three to seven years, from both LSES and HSES families (Huang et al., 2017). Children were presented with spoken active and passive sentences, along with three objects that represented an expressed item (e.g. *seal*), a likely theme (e.g. *fish*), and a likely agent

(e.g. *shark*) in each sentence. Participants were split into a strong bias and weak bias group. Children in the strong bias group heard the agent as a definite noun phrase *the seal,* in both the active and passive sentences, such as *the seal is quickly eating it.* This creates a strong agent-bias for the first noun phrase in the sentence. The children in the weak bias condition heard a pronoun as the agent in both the active and passive sentences, such as *it is quickly eating the seal*. This creates a weak agent first bias, as the pronoun is ambiguous, and assignment of roles cannot occur until after the verb. Therefore, not only will the passive structures be harder in both groups, but children in the weak bias condition will make more mistakes overall when assigning roles. Eye-tracking was used to assess children's role assignment of the agent and theme when the sentences were presented. Additionally, participants were required to act out the sentence heard using the objects. A receptive vocabulary task was also administered.

Initial results from Huang et al. (2017) showed that vocabulary size was higher in children from HSES families. Further results showed an interaction between family income and construction type, showing that in the strong bias condition, preference for looking at the target item in a passive sentence increased for HSES participants but was unchanged for LSES participants. This shows that HSES children looked faster at the target item than LSES children in the harder passive sentences. A similar result was found for the weak bias condition, where the role assignment is delayed until after the verb. Overall, these results suggest a difference in real-time processing of syntactic structures between SES groups.

Additionally, when participants were asked to act out the sentences, results showed that accuracy for active sentences was equal across both strong and weak bias conditions. As expected, all children were less accurate when acting out passives compared to actives in the strong bias condition. LSES children performed less

accurately than HSES children in the strong bias condition, showing an effect of SES. Huang et al. (2017) suggest that this result is not due to learning the structures, but accessing the structures in real-time, concluding that the difference in experience between SES groups create the difference in retrieval times when accessing the structures in real-time.

The results of Huang et al. (2017) support the findings of Weisleder and Fernald (2013) in younger children. When testing children aged 1.5 to 2 years, it was found that amount of child-directed speech, which differs between SES groups (Hart & Risley, 2003; Rowe, 2008), significantly correlated with efficiency of language processing, showing that the more child-directed speech heard, the more efficient a child's processing of familiar words in real time. This supports the role of SES in real-time processing of language in children.

To conclude, this section has provided a summary of statistical learning, a key mechanism in language processing. Experimental evidence has also been provided to show the effect of language exposure in sentence processing, and additionally, how experience might contribute to the relationship between SES and language processing.

1.3 Summary: Bridging the gap between socio-economic status, language exposure, and sentence processing

As has been shown in this literature review, SES has a strong impact on an individual's language development. Within SES, there are many variables that need to be considered. Many of these variables may be interrelated; therefore, unpicking specific variables that influence language ability is important. Based on reviewing a range of previous research, language exposure has been shown to be important for both

word learning and sentence processing. Yet less research has been conducted on the role of SES and language exposure in young adults, and the relationship of this with language processing. Previous research has found that the brain continues to mature beyond adolescence and into adulthood, perhaps until age 30 (Blakemore & Choudhury, 2006). For example, the areas of the brain responsible for language, as well as other cognitive abilities, continue to develop into adulthood (Blakemore, 2009).

Therefore, the goal of this research was the following: first, to develop a set of measures to assess cumulative written and spoken language exposure in young adults, and provide preliminary evidence for each measures' construct validity, and second, to assess the relationships between three key variables: SES, written and spoken language exposure, and language processing. Within this, three specific research questions will be addressed:

(1) Is there is a relationship between SES and language exposure, both written and spoken, in a sample of young adults?

(2) Is there a relationship between SES and language processing in young adults?

(3) Do differences in language exposure relate to language processing in young adults, particularly for complex syntactic structures?

Chapter 2: Development of Measures of Written and Spoken Language Exposure in Young Adults

2.1 Introduction

This chapter will describe and review a comprehensive set of measures which assessed socio-economic status and language exposure. This set of measures combined existing validated measures of written and spoken language exposure, along with newly developed measures, such as a sentence structure familiarity rating task, to assess variation of different language inputs.

2.1.1 Socio-economic status

Socio-economic status (SES) is referred to in much of the literature, in both social sciences and health sciences, as a multidimensional measure that is not restricted to one variable (see Braveman et al., 2005, for review). SES has been measured in children using many different indicators; the most robust being family income, parental education (most often maternal education), parental occupation, and mostly in western cultures, access to free school meals (Betancourt, Brodsky, & Hurt, 2015). When assessing SES in adults, respondents are asked about their own education, occupation and household income.

Income, education, and occupation are known as compositional measures of SES, which, as defined by Shavers (2007), means that the questions focus around the behavioural characteristics of an individual rather than the environment. While family income may be a sensitive measure of current living standards, it is subject to change more frequently than factors such as parental education and occupation. Therefore, family income can be considered as somewhat of a snapshot measure of SES, rather than an indication of long-term SES (Payne, Whitehurst, & Angell, 1994; Sirin, 2005).

SES, as a combination of these indicators, has support from previous research indicating a relationship to cognitive development and educational progression throughout childhood and adolescence (see Hoff, 2013, for review). In young adults, such as university students, it is much more difficult to assess SES, compared to children and adults. Many university students leave the family home, and parental education, parental occupation and income may not directly relate to their circumstances as much as it would as a child. However, they do not yet have a stable income, occupation or education, as they are continuing further study. This makes it difficult to categorise young adults when assessing SES. Shavers (2007) evaluates the issues regarding measuring SES and suggests using a multilevel approach, which combines compositional measures, such as income and education, and contextual measures, such as neighbourhood and geographic area. However, Sirin (2005) suggests that including neighbourhood or geographic measures combined with compositional measures could cause misinterpretation of group-level data as individual-level data.

Therefore, it is clear that measuring SES in a sample of young adults is complex. In the current study, the relationship between SES and language exposure and language processing will be assessed in young adults. SES was measured using indicators of parental education, parental occupation and household income.

2.1.2 Language Exposure

Without taking longitudinal observations of reading behaviour, exposure to language is a hard concept to measure accurately. The first studies to measure print exposure relied on the use of diary methods and self-report measures, such as asking parents to report information on frequency of joint reading with children, number of books read in joint reading, number of books in the home, interest in reading, and trips

to the library (e.g. DeBaryshe, 1993). Although self-report measures are quick and easy to administer, they can lead to some inconsistencies. For example, when asking about how many times a week a parent reads to a child, this is ambiguous in that some parents might categorise one book as one event, whereas another parent might read three or four books in one sitting and categorise that as one event (e.g. Sénéchal, LeFevre, Hudson, & Lawson, 1996). Therefore, care must be taken when assessing using self-report measures. Another issue is that self-report measures are also at risk of social desirability as reading is a highly valued activity in western cultures, therefore, participants may answer falsely (DeBaryshe, 1995).

To overcome socially desirable responses, Stanovich and West (1989) developed the Author Recognition Test (ART) to measure text exposure in adults. The ART is a list of names, some of which are names of adult fiction and non-fiction authors, taken from best-selling lists, and the remaining are random names created as foils. Respondents completing the ART are asked to mark which names they recognise as being real authors, even if they have not read the authors' books themselves. Respondents are advised not to guess due to a penalty being given for incorrect answers. While the authors do not claim that the ART is a measure of total reading, the test assesses a particular type of knowledge based around reading. The test assumes that the more widely read an individual is, the more accurate the individual will be at recognising other authors, even if they have not read the authors' books (Moore & Gordon, 2015). Acheson, Wells and MacDonald (2008) argue that because individuals are only asked about recognition of authors, rather than being directly asked about their own reading habits, they are less likely to put a socially desirable answer.

The original ART by Stanovich and West (1989) included both non-fiction and fiction authors, from a range of genres. When testing young adults, Stanovich and

West's (1989) study showed that the ART correlated with a Reading Habits questionnaire used in the study, although not highly (.38), and predicted additional variance in word recognition skill (10.5%) and spelling ability (11.9%) after phonological and orthographic variables had been accounted for. These findings demonstrate that the performance on the ART test is related to an individual's reading habits, and moreover that it predicted their language processing (e.g. word recognition). Similarly, using multiple measures of text exposure, including both self-report measures and an updated version of the ART, Acheson et al. (2008) found that in a sample of young adults, the ART reliably correlated with questions on the Comparative Reading Habits (CRH) measure such as enjoyment of reading (r=.52) and reading time of fiction and non-fiction books (r=.41 and r=.31, respectively). The CRH measure requires respondents to indicate their reading habits compared to their peers. These results show that the ART is related to other measures of reading habits, without directly asking, as seen from the replication of significant correlations with reading habits. However, studies such as Acheson et al. (2008) have found that in a hierarchical regression predicting reading skill, the ART became a non-significant predictor after the CRH measure was entered. This could suggest that as the ART is an indirect measure of reading habits, it is not as strongly related to reading skills as more direct measures, such as the CRH.

The original ART aimed to measure extra-curricular reading, and therefore included bestselling authors that would not be read in school (Stanovich & West, 1989). Some previous studies chose not to include literary authors giving the reasons that this would bias the results (Masterson & Hayes, 2007). It has been suggested that, if literary authors were included, the respondents who would score highly on the ART would

most likely be those who have studied these authors as part of their education, rather than have read them as an extra-curricular activity (Masterson & Hayes, 2007).

The study by Moore and Gordon (2015) examined whether the frequency of authors in print, such as how often an author appears on a best-selling list, influences how difficult the author is in the ART. A factor analysis conducted on the items within the ART found that the frequency of the author in print reduced the difficulty of recognising the author in the ART. The study also found that when splitting respondents into those that read more often and less often, less frequent authors, such as Saul Bellow, provided more informative data for those that read more often, than more frequent authors, as individuals that read more are likely to correctly select the frequent authors. In contrast, the frequent authors, such as Ernest Hemingway or Stephen King, provided more information for those that read less, as these respondents are unlikely to select many authors. Following this, item response theory was used to analyse the ART in more depth. Item response theory is a way of assessing the difficulty of each item within a test, in order to explore which items are the most reliable for the measure, and as a result, designing a more robust measure. Performing item response analysis allows measures such as the ART to be updated without losing the reliability and validity of the original measure (Kean & Reilly, 2014). Having considered the suggestions stated by Moore and Gordon (2015) after the item response analysis, the ART was updated in the current study. Moore and Gordon (2015) additionally suggest that future versions of the ART should include a points system, whereby points are given for a correct author and points are deducted for incorrectly identifying an author, in order to try and stop participants from guessing. The same principle was applied in the current study.

Along with the ART, several studies have used questionnaire-based self-report measures to assess the types of language individuals are exposed to. Stanovich and

West (1989) measured language exposure through a reading and media habits questionnaire, along with the original version of the ART and a magazine recognition test (MRT). The reading habits questionnaire included asking respondents how many books they read in a year, how often they visit bookstores, how often they read newspapers, and how much television they watch per day. The results from the study showed that the ART and MRT significantly correlated with the reading and media habits questionnaire (r= .38 and r=.36 respectively).

Another study that assessed language exposure using a self-report method was Acheson et al. (2008). Acheson et al. (2008) used an updated version of the ART and created a questionnaire to measure Reading Time and CRH in university students. The Reading Time measure assessed how much time an individual spends reading different types of material, such as textbooks, fiction books, newspapers, and magazines. One limitation of these questions, which is briefly mentioned in the study, is that slower readers will spend longer amounts of time reading per week. Therefore, longer reading times may not reflect more reading per se, and this will differ between participants. Thus, it is important to include other measures of reading habits, such as comparative measures, to fully understand how much time an individual spends reading. The CRH measure assessed how much time an individual spends reading different types of material compared to their peers (other university students). Acheson et al. (2008) found that the print exposure measures were reliably correlated with one another. Dissociations were found between items that assessed academic and non-academic reading. Additionally, in a hierarchical regression predicting reading skill, the ART became a non-significant predictor after the CRH measure was entered. Chen and Fang (2015) suggest that this supports the use of self-report measures, in addition to the ART, when assessing reading habits.

In the current study, four measures were used to assess written language exposure: three questionnaire-based self-report measures, and an adapted version of the ART. The first self-report measure, the Reading Habits questionnaire, was adapted from measures used in Stanovich and West (1989) and Hamilton, Hayiou-Thomas, Hulme, and Snowling (2016) which focused on measuring book reading habits (e.g., number of books read, visits to bookstores, number of books in the home). The second self-report measure, the Reading Time questionnaire, was adapted from Acheson (2008) and assessed the time spent reading a variety of print and online materials (e.g. fiction, academic materials, e-mail, content on social media). The final self-report measure, the Comparative Reading Habits questionnaire, adapted from Acheson (2008), assessed reading habits compared to peers, including questions concerning reading fiction, academic material, complexity of reading material, and enjoyment of reading.

In addition to measuring written language exposure, spoken language exposure was also assessed. Corpus studies have shown written and spoken language to have different proportions of simple and complex language (Montag & MacDonald, 2015; Roland, Dick, & Elman, 2007), and therefore, this study aimed to capture the language individuals are exposed to in spoken language.

A measure of spoken language exposure was developed based on the Language Experience and Proficiency Questionnaire (LEAP-Q: Marian, Blumenfeld, & Kaushanskaya, 2007). This measure asked respondents to indicate how much time they typically spend in different language contexts, encompassing both listening to spoken language and communicating with others in real-time using language (e.g. talking with friends and family, online messaging, texting, watching TV, and listening to music).

2.1.3 Assessing Sentence Structure Exposure

Most of the research discussed so far has assessed written language exposure, specifically concerning book-level exposure. There is a lack of research into exposure of more specific areas of language, such as, for example, specific sentence structures. As discussed in Chapter 1, according to the statistical learning theories (e.g. MacDonald & Christiansen, 2002; Montag & MacDonald, 2015; Wells, Christiansen, Race, Acheson, & MacDonald, 2009), the amount of exposure to different types of sentence structures influences how quickly and how accurately they are processed. Thus it is important to establish an individual's level of exposure to different types of structures.

The English language has a diverse range of sentence structures, some that follow the typical subject-first word order, and others that follow an atypical object-first word order. Within their study, Roland et al. (2007) analysed the frequency of different sentence structures in a range of written and spoken corpora. The corpora used included the Penn Treebank versions of the Brown corpus, which are samples of written text from a range of genres; the Wall Street Journal, which includes samples of written text from the business sector; and the Switchboard corpus, which are samples of spoken phone conversations. Additionally, data were analysed from the British National Corpus (BNC), which includes written and spoken samples of English language from a range of genres. As the authors suggest, although these corpora provide a range of structures over a range of discourse, it cannot give an exact representation of the English language (Roland et al., 2007). A total of 25 structures were identified in the corpora; 18 of these were subject-first structures, which were more frequent in written and spoken language than object-first structures.

Corpus studies such as Roland et al. (2007) provide a broad measure of different types of structures and their frequency in a particular language. However, corpus-based

measures are less appropriate for measuring frequency of exposure to different sentence types in individuals. Thus, in the current study a new measure was developed to assess an individual's exposure to several types of frequently studied sentence structures in English, such as subject and object relative clauses. This measure assessed familiarity ratings of simple and complex sentence structures, with the assumption that the more an individual is exposed to certain structures, the more familiar they will be with those structures.

The following sections present a newly developed questionnaire measure to assess SES and language exposure, based on the literature reviewed. Each measure within the questionnaire was either newly developed or adapted from previous research and will be discussed in detail below. Any adaptations that were made to previously used measures will be outlined. This questionnaire was piloted on a sample of undergraduate students. This sample is also used in Chapter 3 to analyse relationships between the three key constructs of interest: SES, language exposure and language processing.

2.2 Method

2.2.1 Participants

Two-hundred and fifty-four participants (54 males, 199 females) aged 18 to 29 years (M = 20.66, SD = 2.25), took part in this study. Participants were recruited through opportunity sampling. Sixty participants completed the questionnaire online remotely, and the remaining 194 participants completed the questionnaire in a controlled laboratory setting. Participants received payment or course credit for their participation. Participants who completed the questionnaire in the laboratory also

completed four standardised tests, measuring receptive and expressive grammar, vocabulary, and non-verbal ability. These measures will be further discussed in Chapter 3. The study protocol was approved by the Ethics Committee at York St John University.

Two-hundred and twenty-six participants reported no learning difficulties. Twenty participants reported additional difficulties, including dyslexia and autism. Two-hundred and forty-eight participants reported speaking English as their first language, with 115 reporting being moderately fluent or completely fluent in one or more additional language. For the purposes of the current analyses, six participants were excluded based on being non-native speakers of English, and a further 15 were excluded due to reporting reading or language difficulties (14 reporting dyslexia, 1 reporting a problem with reading comprehension). Data for an additional eight participants was removed due to incomplete questionnaire data. Therefore, analyses were conducted on data for the remaining 224 participants (47 Males, 177 Females).

2.2.2 Pilot Study

Three focus groups were conducted in order to pilot the questionnaire before commencing with the first study. The objective was to receive constructive feedback concerning issues with the layout, accessibility, and content of the questionnaire. Five participants in total attended the focus groups: one participant in the first group, two in the second group, and two in the third group. Participants were recruited from the university where the main sample would be recruited and received payment for taking part. After signing a consent form, participants were required to complete a paper version of the questionnaire and then discuss any evaluations. All sessions were recorded with the permission of the participants. The focus groups were primarily used

for feedback on the sentence structure familiarity rating tasks, as this is a novel task, whereas the other sections are based on measures from previous research and have therefore already been validated. Comments were considered, and modifications were made before using the final version of the questionnaire in the study, which are discussed throughout the subsequent sections.

2.2.3 Measures

2.2.3.1 Socio-Economic Status

SES was measured using indicators of parental occupation, parental education, and household income. Familial SES was investigated due to most respondents being university students, and thus unlikely to have a stable income or occupation at the current time. Parental occupation was assessed using the Office for National Statistics (ONS) Standard Occupational Hierarchy 2010 (Elias & Birch, 2010). The ONS sets out ten classifications of occupation that range from *Manager, director or senior official* to *Unemployed, full-time student or full-time parent*. Parental education was measured using six categories, ranging from *Postgraduate degree* to *No formal education.* Participants were asked to indicate both their mother's and father's occupation and education separately. Comments from focus groups suggested adding a *don't know* option for parental occupation and education, as participants may come from a single-parent family or are unsure of their parent's occupation or education. Household income ranged from £*0* to £*100,000+ per year,* increasing in sets of ten thousand. A list of the familial SES questions can be found in Appendix 1.

2.2.3.2 Language Exposure

To assess written language exposure, four measures were adapted from previous research which assessed reading habits, comparative reading habits, reading time, and

author recognition. A separate set of questions was designed to assess spoken language exposure.

Reading habits: Two questions were adapted from Stanovich and West (1989), including how many books individuals read in a year, not including academic materials, with answer options ranging from *none* to *40+*, and how often individuals visit bookstores, with answer options ranging from *never* to *once or more a week*. A third question was included, which followed the previous layout, but asked how often a participant visits online bookstores (e.g. Kindle store, Amazon bookstore). This allowed for the inclusion of online purchasing of books and digital versions of books, such as e-books, which have become popular since the original version by Stanovich and West (1989) was released. Answer options were changed from the original study following the comments of focus groups, in order to include a broader range of answer options. For example, the original answer options for how often an individual visits a bookstore included *never, once or twice a year, once or twice a month,* and *once or more a week.* The additional option of *several times a year* was added as the third option to break up the large difference between *once or twice a year* and *once or more a month.*

A fourth question was adapted from the questionnaire used by Hamilton et al. (2016) which asked how many books there are in the family home, with answer options ranging from *none* to *200+*. However, this question could be misinforming with the recent popularity of e-books, where individuals can hold many electronic versions of books on one device. Therefore, in order to gage exposure to written language more completely, the following sections further investigated an individual's exposure to different aspects of written and spoken language. A copy of the reading habits section can be found in Appendix 5.

Reading time: Eleven questions were adapted from Acheson et al.'s (2008). Reading Time Estimates section. This section covered both paper-based and online-based reading materials, including textbooks, academic material other than textbooks, fiction books, non-fiction/special interest books, graphic novels, magazines, newspapers, e-mail, reading content on social media, and internet media. An option was given at the end of the section for participants to add other reading materials that are not listed. The question regarding graphic novels was added after piloting the questionnaire, on the recommendations of respondents. Answer options ranged from *0* to *7+ hours per week.* A copy of the reading time section can be found in Appendix 7.

Comparative reading habits: Six questions were adapted from Acheson et al.'s (2008) Comparative Reading Habits (CRH) questionnaire which measures how much time an individual spends reading, compared to their peers. The first question asked *Compared to other college students, how much time do you spend reading all types of materials?* The wording of the questions was changed to *compared to other people your age* which allowed for a broader range of respondents, in addition to university students. In the current study, to assess different types of reading materials more specifically, this question was split into three questions asking how much time participants spend reading academic material, fiction, and newspapers and magazines (in print and online). This gave an initial indication of the types of materials an individual reads rather than just reading in general. The second question from Acheson et al. (2008) asked how complex respondents think their reading material is. This question was changed to ask about complexity of non-academic material (e.g. fiction, newspapers) only. The third question from Acheson et al. (2008) asked how much the respondent enjoys reading. Along with the questions taken from Acheson et al. (2008), one additional question was included

that asked how much time an individual spends on social media, compared to other people their age.

The answer options were changed from the original questionnaire. Acheson et al. (2008) asked participants to rate comparative reading habits on a scale of 1-7 with higher numbers representing longer reading times and higher complexity. To avoid confusion with previous sections of the questionnaire, which included a 1-7 scale that represented hours per day, the scale for the CRH section was changed to include five answer options ranging from *much less than others* to *much more than others*. This allowed continuity of categorical options to follow on from the previous reading habits section of the questionnaire. A copy of the comparative reading habits section can be found in Appendix 6.

Author Recognition Test: The written language exposure measures also included an adapted version of the ART created by Stanovich and West (1989). The first draft of the ART was the version used in Hamilton (2013). Within this, 40 authors from a range of genres and 40 foils were included. Ten foils were removed to make the test shorter for the purposes of this study. The following adaptations were made to the ART using the guidelines suggested by Moore and Gordon (2015).

First, unlike in the study by Stanovich and West (1989), both literary and popular fiction authors were included. This is due to the results of Moore and Gordon's (2015) factor analysis which suggested that knowledge of popular and literary authors can be measured independently and relate differently to reading habits. Twenty-two of the authors used were taken from Moore and Gordon (2015; 12 literary, 10 popular), the other 18 authors were chosen from frequently occurring names on several best-seller lists, based on the categories of popular and literary. The authors taken from Moore and Gordon (2015) were chosen based on the selection rates given for each author used in

the study. As the authors included in the ART must be culturally specific to the sample being tested, 21 authors were of British nationality (12 literary, 9 popular), along with other internationally recognised authors in the English language. All the authors chosen were writers of fiction books. Although biography and other non-fiction authors have been used in previous versions of the ART (e.g. Masterson & Hayes, 2007), this was not adopted in the current study.

The literary category, which are authors most likely studied within education (Moore & Gordon, 2015), included both classic literary and contemporary literary authors. Authors in the classic literary group included Ernest Hemingway and George Orwell, that had a high selection rate in Moore and Gordon (2015). The contemporary literary group, defined as authors who published books after 1945, included authors such as Margaret Atwood and Vladimir Nabokov. Examples of popular authors include Stephen King, James Patterson, Clive Cussler and Martina Cole, which are defined as authors whose books are encountered outside of the classroom and may have been adapted into popular movies. It is important to note that 91% of the authors in this study that were categorised as literary and popular authors, also fell into the categories of literary and popular in previous studies when a factor analysis was conducted (2015). A copy of the ART can be found in Appendix 8.

Spoken language exposure: A new measure of spoken language exposure was created, based on the Language Experience and Proficiency Questionnaire (LEAP-Q: Marian et al., 2007), to assess general spoken language exposure. One section was created which asked respondents to indicate how much time they typically spend in different language contexts, encompassing both listening to spoken language and communicating with others in real-time using language. This included talking with friends and family, watching TV, watching online video clips, internet media (such as

online forums), online messaging, texting, and listening to music with lyrics. Answer options ranged from *0* to *7+ hours per week*, which is identical to the answer options in the reading time question. A copy of the spoken language exposure section can be found in Appendix 11.

2.2.3.3 Sentence Familiarity Rating Tasks

Two tasks were developed to measure an individual's familiarity with a range of different syntactic structures that are present in the English language. The syntactic structures used in the two tasks were chosen based on the structures present in written and spoken corpora of English, as found in Roland et al. (2007). The sentences chosen have also been used in previous studies measuring online sentence processing (e.g. Montag & MacDonald, 2015; Wells et al., 2009).

Twenty-one syntactic structures were included and were split into two groups: structures that followed a subject-first word order and structures that followed an object-first word order. This included 14 subject-first structures and seven object-first structures, which is reflective of the ratio of subject-first and object-first structures found in the English language (Roland et al., 2007). Two items were developed to represent each structure tested. A complete list of the different structures used can be found in Appendix 12.

In addition to including a range of syntactic structures, sentences were also controlled in several ways for the factors that are relevant for online sentence processing (Gennari & MacDonald, 2009; Montag & MacDonald, 2015; Roland et al., 2007). Across all the structures, there were a total of 82 unique nouns in the place of the subject and object in each sentence. The relative proportions of different types of noun phrases were equated across subject-first and object-first sentences, which included

approximately 35 percent common animate nouns, 40 percent common inanimate nouns, 15 percent proper nouns, and 10 percent personal pronouns.

The study by Roland et al. (2007) also analysed instances of a range of verbs in each structure. These results were utilised in the current study, however, only the results for the written and spoken British National Corpus (BNC) was consulted as the current study was run with speakers of British English. Verbs were chosen based on their frequency in each of these corpora. The purpose of this was to ensure that sentence familiarity was rated on the sentence structure rather than due to the individual verbs occurring more- or less-frequently in specific structures in the English language. Using log frequency data from the study by Van Heuven, Mandera, Keuleers, and Brysbaert (2014), verb frequencies were approximately matched across the lists of SV and OV sentences (22,267 overall subject-first verb frequency and 28,825 overall object-first verb frequency). Each verb was only used in one sentence and was never repeated. The sentences created were used in two familiarity rating tasks.

The main aim of the first familiarity rating task was to assess overall familiarity of subject-first and object-first sentence structures. The task included a list of 42 sentences, which was made up of two sentences from each of the 21 syntactic structures chosen from Roland et al. (2007; 14 subject-first, 7 object-first).

Participants were required to read each sentence individually and indicate how often they are likely to encounter the sentence based on its structure. To do this, a seven-point rating scale was used, which ranged from *1* to *7*, with *1* indicating *Very Rarely*, *4* indicating *Sometimes*, and *7* indicating *Very Often*. The instructions given at the start of both sentence familiarity rating tasks gave an example of how the structure would be rated rather than the meaning. The instructions gave two example sentences: (1) *John ate a tomato pizza at the local restaurant yesterday*, and (2) *Yesterday, a tomato pizza*

was eaten by John at a local restaurant. The instructions explained that both sentences have the same meaning but have a different grammatical structure. The structure of sentence (1) might likely be encountered very often, and therefore have a high rating. Whereas, the structure in sentence (2) might be encountered less often and so would have a low rating.

This task also included eight ungrammatical sentences used as foils, to make sure respondents are paying attention, which should always be scored as *Very rarely*. The mean scores for subject-first and object-first structures were used in the subsequent analyses. The items used in this task and the instructions given to participants, can be found in Appendices 13 and 14.

The second familiarity rating task was created to provide a comparative measure of sentence structure familiarity. This task used a selection of the sentences from the first task, along with some additional sentences. This task was designed to assess the familiarity of a subset of sentence structures which express the same meaning using a different word order. For example, a sentence containing an object relative clause, e.g. *The pasta that the chef cooked was very tasty* has the same meaning as a sentence containing a passive relative clause, e.g. *The pasta that was cooked by the chef was very tasty*. Therefore, keeping the meaning of the sentence the same ensures that a difference in familiarity is due to the difference in the structure (subject-first versus object-first) rather than a difference in the meaning. The structures used in this task included 13 actives and passives, 15 active (object) and passive relative clauses, and eight ditransitive sentences. The same eight ungrammatical sentences used in the first task were also included, along with the grammatical counterpart. In this task, participants were required to read both sentences in each set of structures and rate them by comparing how familiar each sentence structure is. The sentences from each structure

were also split into different groups containing different noun pairs, covering animate-animate, inanimate-animate, and inanimate-inanimate noun pairs. This was controlled in this way due to animacy being found to affect how easily sentences are comprehended. For example, object relative clauses, which do not follow a standard word order, are harder to comprehend when both nouns are animate, such as *the boy that the girl kicked was wearing blue shorts* (Gennari & MacDonald, 2009). The same rating scale as in the first sentence familiarity task was used. For this task, mean scores for each structure (active, passive, ORC, PRC and ditransitives) was used in the subsequent analyses. The items used in this task can be found in Appendix 15.

Participants who took part in focus groups indicated that the comparative familiarity rating task was easier to complete than the individual familiarity rating task, in which the sentences were presented independently. Some participants stated that they did not fully understand the instructions, but when completing the task, it became clear what was required of them, especially in the comparative rating task. Therefore, the order of the questionnaire was created so that the comparative rating task was completed before the individual rating task, in order to address this.

2.3 Results

The results section is structured in the following way. Three sections will be presented to analyse the two theoretical constructs (SES and language exposure) and the newly developed measure of sentence structure familiarity. Descriptive statistics will be presented for each of the indicators, followed by correlational analyses to assess the extent to which the different indicators of the same construct are interrelated. For

the language exposure construct, an additional factor analysis will be presented. Test-retest reliability will also be presented for the language exposure measures.

2.3.1 Socio-Economic Status

2.3.1.1 Descriptive Statistics for Socio-economic Status

As illustrated in Table 2.1., individual indicators of SES showed the use of the entire scale and mostly normal distributions, demonstrating that the sample included participants from a wide range of SES backgrounds (see Appendix 3 for the histograms for each of the indicators). It should be noted that there was a high rate of *don't know* answers for the income variable (13.8%); this is a common methodological issue with SES variables in research (Shavers, 2007), and therefore means that income should not be used as a single indicator of SES, but rather combined with the other indicators as part of a composite measure.

Table 2.1
Descriptive statistics for SES items

Item	*N*	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Mother's Education *(1= no formal qualifications, 2= GCSE's or equivalent, 3= A-levels or equivalent, 4= post-18 qualification, 5= undergraduate degree, 6= postgraduate degree)*	203	3.12 (1.62)	3 (1-6)	.25	-.61
Father's Education *(as previous item)*	209	3.17 (1.81)	3 (1-6)	.10	-1.10
Mother's Occupation *(1= unemployed, 2= full-time student or full-time parent; 3= elementary occupation; 4= process, plant, or machine operative; 5= sales or customer service occupation; 6= caring, leisure or other service occupation; skilled trades occupation; 7= administrative or secretarial position; 8= associate professional or technical occupation; 9= professional occupation; 10= manager, director or senior official)*	222	5.85 (3.24)	7 (1-10)	-.310	-1.28
Father's Occupation *(as previous item)*	206	6.59 (3.45)	8 (1-10)	-.68	-.92
Household Income *(1= £0-£10,000; 2= £10,000-£20,000; 3= £20,000-£30,000; 4= £30,000-£40,000; 5= £40,000-£50,000; 6= £50,000-£60,000; 7= £60,000-£70,000; 8= £70,000-£80,000; 9=£80,000-£90,000; 10= £90,000-£100,000; 11= £100,000+)*	193	4.36 (2.99)	5 (1-11)	.41	-.37

Note: s.d. = Standard Deviation

2.3.1.2 Correlational Analysis of SES Indicators

As shown in Table 2.2, the SES items are weak-to-moderately intercorrelated. Mother's occupation was only weakly correlated with father's occupation, and it was not correlated with father's education. Additionally, mother's education was only weakly correlated with household income.

Table 2.2
Inter-item Correlations of Individual SES variables

	1.	2.	3.	4.	5.
1. Mother's Education					
2. Father's education	.33**				
3. Mother's occupation	.36**	.07			
4. Father's occupation	.20**	.29**	.16*		
5. Household Income	.16*	.18**	.41**	.36**	

*Note: *p<.05; **p<.01*

2.3.2 Language Exposure

2.3.2.1 Descriptive Statistics for the Language Exposure Measures

Reading habits: The set of questions in this self-report measure focused on the habits related to book reading. As shown in Table 2.3 the range for each question shows that for all items, participants used the entire scale. Skewness and kurtosis suggest that the results for items in this section are approximately normally distributed. On average, participants reported reading approximately three to ten books per year and reported visiting bookstores several times a year. Participants also reported having an average of 51 to 80 books in their family home.

Table 2.3
Descriptive Statistics for the Reading Habits Section of the Questionnaire

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Number of books read in a year *(Not including academic material; 1= none; 2= one or two, 3= 3-10, 4= 11-20, 5= 21-40, 6= 40+)*	2.86 (1.04)	3 (1-6)	.71	.85
Frequency of bookstore visits *(1= never, 2= once or twice a year, 3= several times a year, 4= once or twice a month, 5= once or more a week)*	2.64 (1.02)	3 (1-5)	.05	-.67
Frequency of online bookstore visits *(as previous item)*	2.58 (1.31)	2 (1-5)	.65	.18
Number of books in family home *(1= none, 2= 1-10, 3= 11-30, 4= 21-50, 5= 51-80, 6= 81-150, 7= 150-200, 8= 200+)*	5.27 (1.84)	5 (1-8)	-.11	-1.01

Note: s.d. = Standard Deviation

Reading time: The questions in this self-report measure assessed the amount of time spend reading a range of print and online materials. The Reading Time section showed the most variability in scores, as can be seen from the median scores in Table 2.4. This shows that the measure is capturing differences in time spent reading different materials. For variables such as time spent reading newspapers, magazines and graphic novels, median scores are very low on the scale. A high skewness and kurtosis show that a small number of respondents are reading these types of materials frequently, while most are engaging with these materials only one or two hours per week. In contrast, scores for time spent reading content on social media have a negative skew, showing many respondents spend a large amount of time reading content on social media.

A general finding within the distributions was that time spent reading all types of material was low (e.g. time spent reading fiction books, *Mdn* = one hour per week). Additionally, there is a low median result for textbooks and other academic material, showing that on average participants do not spend very long reading this type of material each week (*Mdn* = two hours per week). The original study also found similar time spent reading fiction, textbooks and academic material (Acheson et al., 2008). This pattern has also been found in previous research which found that students were reading far less than expected for a higher education course, with recreational reading time also very low (Jolliffe & Harl, 2008; Sheorey & Mokhtari, 1994). Sheorey and Mokhtari (1994) attributed this to the rising need for students to also engage in part-time work alongside the degree, and therefore not having an adequate amount of time to spend reading, while Jolliffe and Harl (2008) recorded that students would rush through the academic reading to move onto other, more engaging activities.

Distributions of time spent reading content on social media shows that 65 percent of respondents indicated that they spend five or more hours per week on social media, with 54 percent revealing they spend several hours a day online messaging (e.g. Facebook messenger, WhatsApp, Snapchat).

Table 2.4
Descriptive Statistics for the Reading Time Section of the Questionnaire

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Time spent reading textbooks *(1= 0hours, 2= 1hour, 3= 2hours, 4= 3hours, 5= 4hours, 6= 5hours, 7= 6hours, 8= 7+ hours per week)*	3.37 (1.96)	3 (1-8)	.82	-.01
Time spent reading academic material other than textbooks *(as previous item)*	3.83 (2.09)	3 (1-8)	.60	-.56
Time spent reading fiction books *(as previous item)*	2.91 (2.09)	2 (1-8)	1.09	.21
Time spent reading non-fiction/special interest books *(as previous item)*	2.16 (1.50)	2 (1-8)	1.67	2.88
Time spent reading graphic novels *(as previous item)*	1.44 (1.14)	1 (1-8)	3.13	10.43
Time spent reading magazines *(as previous item)*	1.67 (1.08)	1 (1-7)	2.42	7.04
Time spent reading newspapers *(as previous item)*	1.89 (1.40)	1 (1-8)	2.26	5.85
Time spent reading e-mail *(as previous item)*	3.52 (1.75)	3 (1-8)	1.19	.87
Time spent reading content on social media *(as previous item)*	6.08 (1.98)	6 (1-8)	-.57	-.99
Time spent reading internet media *(as previous item)*	3.52 (2.06)	3 (1-8)	.74	-.34

Note: s.d. = Standard Deviation

Comparative reading habits: Table 2.5 shows descriptive statistics for the CRH measure. Mean scores for CRH questions show that, on average, participants rate themselves as about the same or less than others for all types of reading. The results show that respondents report they have typical reading habits for their age, following a similar pattern to the original study (Acheson et al., 2008). Some variation does emerge in CRH time spent reading fiction, CRH newspapers and magazines, and CRH enjoyment.

Additionally, the CRH items can be utilised in two ways: (1) to inform on how respondents believe that their reading habits compare to others of the same age; and (2) when respondents are completing the other sections of language exposure, such as time spent reading different types of material, whether the indicated time represents what the respondent believes is more, less, or the same as, other people of the same age.

For example, distributions of time spent reading content on social media shows that 65% of respondents indicated that they spend five or more hours per week on social media, with 54% revealing they spend several hours a day online messaging (e.g. Facebook messenger, WhatsApp, Snapchat). When comparing these statistics with the comparative social media question, 60% of respondents indicated that they spend about the same amount of time on social media, compared to other people their age. This shows that respondents believe spending five or more hours per week on social media, and several hours a day on platforms such as Facebook Messenger, is average for their age.

Table 2.5

Descriptive Statistics for the Comparative Reading Habits Section of the Questionnaire

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
CRH time spent reading academic material *(Compared to others of the same age; 1= much less than others, 2= less than others, 3= about the same as others, 4= more than others, 5= much more than others)*	3.07 (.89)	3 (1-5)	-.13	.40
CRH time spent reading fiction *(as previous item)*	2.93 (1.11)	3 (1-5)	-.04	-.72
CRH time spent reading newspapers and magazines *(as previous item)*	2.72 (1.08)	3 (1-5)	-.08	-.87
CRH complexity of non-academic material *(as previous item)*	3.04 (.76)	3 (1-5)	-.44	.82
CRH enjoyment of reading *(as previous item)*	3.48 (1.07)	4 (1-5)	-.65	.08
CRH time spent on social media *(as previous item)*	3.00 (.85)	3 (1-5)	-.05	1.08

Note: s.d. = Standard Deviation

ART: In addition to the three self-report measures reported above, the ART was used to assessed written language exposure. Table 2.6 shows descriptive statistics for the ART. Scores for the ART showed that participants correctly identified approximately 11 out of a total of 40 authors, which is similar to the results of previous studies (Acheson et al., 2008, *M* = 23 out of 65; Stanovich & West, 1989, *M* = 9 out of 50). Mean false alarm rates were less than 1 suggesting that guessing was low. This indicates that participants took note of the penalty for checking incorrect targets. Furthermore, the results showed a good range of correct targets checked which is similar to other studies, particularly Moore and Gordon's (2015) results, which influenced how the ART was updated for the current study. An examination of the results of literary and popular authors separately showed a higher mean number of correct targets checked for literary authors compared to popular authors. This could suggest that, as stated in Moore and Gordon (2015), participants have encountered literary authors in an education setting, and so even those who do not read for pleasure would likely recognise these authors. Selection rates for authors, split into literary and popular authors, are presented in Appendix 9. Selection rates ranged from 1% to 88%.

Table 2.6
Descriptive Statistics for the Author Recognition Test

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Targets checked[1]	11.35 (6.48)	10 (37)	1.07	1.29
Incorrect targets checked[2]	.54 (1.03)	.00 (6)	2.50	7.13
Corrected score *Targets checked - incorrect targets checked*	10.81 (6.38)	10 (38)	1.11	1.57
Literary authors targets checked[3]	6.80 (3.63)	6 (20)	.70	.40
Literary authors corrected score *Literary targets checked - half of total incorrect targets checked*	6.53 (3.61)	6 (20)	.72	.57
Popular authors targets checked[4]	4.55 (3.47)	4 (18)	1.21	1.62
Popular authors corrected score *Popular targets checked - half of total incorrect targets checked*	4.28 (3.40)	3.5 (18)	1.22	1.67

Note: s.d. = Standard Deviation; [1]Total number of items=40; [2]Total number of items=40; [3]Total number of items=20; [4]Total number of items=20

Spoken language exposure: Spoken language exposure was assessed using a series of questions analogues to the reading time questions for written language exposure. Descriptive statistics for the spoken language exposure items are shown in Table 2.7. Median scores show that most participants spend up to several hours a day in each of the contexts presented. Scores show participants talk more with friends than with family and spend one hour or less per day to several hours per week watching TV, watching online video clips and listening to music.

Table 2.7
Descriptive Statistics for the Spoken Language Exposure Section of the Questionnaire

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Time spent talking with friends *(1= never, 2= 1 hour or less a week, 3= 2 to 5 hours a week, 4= 1 hour or less a day, 5= several hours a day)*	4.57 (.82)	5 (1-5)	-1.73	1.97
Time spent talking with family *(as previous item)*	3.43 (1.03)	3 (1-5)	.06	-.75
Time spent watching TV shows *(as previous item)*	4.21 (.97)	5 (1-5)	-.86	-.26
Time spent watching online video clips *(as previous item)*	3.49 (1.25)	4 (1-5)	-.31	-1.04
Time spent talking on internet media (online chat, forums) *(as previous item)*	2.62 (1.51)	2 (1-5)	.33	-1.37
Time spent on online messaging *(as previous item)*	4.25 (.98)	5 (1-5)	-1.08	.07
Time spent texting *(as previous item)*	3.83 (1.11)	4 (1-5)	-.58	-.86
Time spent listening to music *(as previous item)*	4.03 (1.16)	4 (1-5)	-1.07	.22

Note: s.d. = Standard Deviation

2.3.2.2 Correlational Analysis of Language Exposure Items

In order to assess relationships within and between the measures of exposure, correlational analyses were run first. Due to some of the items showing non-normal skewness and kurtosis values, Spearman's correlations were run between exposure items, which are shown in Table 2.8.

Based on the results of previous research, it was expected that the items within each subsection would correlate with one another. The results of Acheson showed moderate correlations between the CRH items, and small- to- moderate correlations between the reading time items. In line with correlational results found in Acheson et al. (2008), CRH items were weak to moderately intercorrelated. The strongest correlation was seen between CRH enjoyment of reading and CRH fiction reading. There was also a negative correlation between CRH social media and CRH academic

material. Additionally, items within the Reading Habits section were moderately intercorrelated, with the strongest relationship seen between number of books read and frequency of bookstore visits. Some small correlations were also seen between the Reading Time items.

Correlations were also significant between the ART and other reading habits and reading time variables. For example, the ART correlated positively with number of books read, frequency of bookstore visits, CRH enjoyment of reading and time spent reading fiction. The original study by Stanovich and West (1989) showed that the ART significantly and moderately correlated with the composite score of the reading habits questionnaire, which was supported in the current study. Similarly, Acheson et al. (2008) found that the ART reliably and moderately correlated with questions on comparative reading and reading time of fiction (r=.41) and non-fiction (r=.31). However, in the current study, the ART only weakly correlated with time spent reading fiction and did not correlate with time spent reading non-fiction.

Furthermore, the spoken language variables are shown to be weakly to moderately intercorrelated with one another. Some correlations within this could explain general contexts in which these behaviours occur. For example, the significant correlations between time spent talking with friends and family, and online messaging and texting could show that a percentage of time spent talking with friends and family could be conducted through online messaging or texting.

A general pattern found in the correlations show dissociations in reading habits between reading for academic and non-academic purposes. Correlations between comparative reading habits and reading time estimates show CRH academic material and reading time estimates of textbooks and academic material to be correlated. In the same way, CRH fiction and CRH enjoyment of reading correlate highly with time spent

reading fiction. Conversely, these two variables show no significant correlations with reading time estimates of academic material.

Correlations between spoken language exposure and written language exposure items are few, with most being negative relationships. The one exception is CRH time spent on social media which positively correlates with several spoken language measures (time spent watching TV shows, watching online video clips, talking on internet media, online messaging, texting, and listening to music).

Table 2.8

Inter-item Correlations of Language Exposure Items

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. RH Number of books read in a year														
2. RH Frequency of bookstore visits	**.54****													
3. RH Frequency of online bookstore visits	**.52****	**.42****												
4. RH Number of books in family home	**.27****	**.30****	**.14***											
5. CRH Time spent reading academic material	**.18***	**.23****	**.23****	**.14***										
6. CRH Time spent reading fiction	**.56****	**.40****	**.32****	**.27****	**.14***									
7. CRH Time spent reading newspapers and magazines	-.07	.00	-.05	-.01	.04	-.03								
8. CRH Complexity of non-academic material	**.15***	**.23****	**.14***	**.17****	**.19****	**.25****	.13							
9. CRH Enjoyment of reading	**.51****	**.37****	**.36****	**.17****	**.24****	**.59****	-.03	**.31****						
10. CRH Time spent on social media	-.06	**-.19****	-.06	-.04	**-.17***	-.10	**.13***	-.07	-.11					
11. RT Time spent reading textbooks	.05	-.06	**.15***	-.02	**.20****	-.03	**-.13***	-.04	.05	.10				
12. RT Time spent reading academic material	**.14***	.10	**.16***	**.14***	**.36****	.02	**-.14***	.04	.10	-.05	**.32****			
13. RT Time spent reading fiction	**.64****	**.47****	**.46****	**.21****	.08	**.72****	-.01	**.14***	**.53****	-.08	.02	.07		
14. RT Time spent reading non-fiction/special interest	**.23****	**.27****	**.33****	.08	.02	**.16***	**.15***	**.19****	**.20****	-.01	.12	.07	**.34****	
15. RT Time spent reading graphic novels	**.16***	**.17***	**.28****	.02	.12	**.26****	-.00	.03	**.13***	-.07	.06	.01	**.30****	**.33****
16. RT Time spent reading magazines	**-.16***	**-.14***	-.03	**-.15***	-.02	-.07	**.44****	-.04	-.10	.12	.04	-.03	-.00	.10
17. RT Time spent reading newspapers	.10	.09	**.20****	-.06	.04	.04	**.38****	.05	.06	-.12	-.06	-.07	**.16***	**.19****
18. RT Time spent reading e-mail	.07	**.13***	**.15***	-.01	.13	-.01	.05	-.00	-.02	-.07	.07	**.20****	.03	**.18****
19. RT Time spent reading content on social media	-.09	-.12	.01	-.01	-.03	-.04	**.15***	-.02	-.01	**.40****	**.14***	.06	-.05	.04
20. RT Time spent reading internet media	-.01	-.06	.04	.00	-.00	.04	**.29****	.11	-.03	**.18****	.03	.06	.03	**.17****
21. ART	**.20****	**.26****	.06	**.26****	.10	.12	**.22****	**.16***	**.15***	-.01	.01	.11	**.14***	**.13***
22. Time spent talking with friends	.05	.03	-.01	**.15***	**-.19****	-.03	-.02	.06	.05	.06	-.09	-.02	-.01	-.06
23. Time spent talking with family	-.10	**-.15***	-.06	-.10	.01	-.09	.12	-.05	-.03	.06	**.21****	-.05	-.01	.02
24. Time spent watching TV shows	-.10	**-.20****	-.13	.05	**-.23****	.02	.07	-.02	-.08	**.18****	-.06	-.13	-.03	-.09
25. Time spent watching online video clips	-.01	.02	.07	.04	**-.23****	.06	.03	.07	.06	**.22****	-.01	-.07	.01	-.01
26. Time spent talking on internet media	.01	-.05	.07	**-.16***	-.09	-.05	.09	.01	-.07	**.25****	**.15***	.01	.00	**.13***
27. Time spent on online messaging	-.02	-.10	.06	.03	**-.14***	.09	.07	-.04	.09	**.32****	.12	-.03	.03	.08
28. Time spent texting	-.08	-.13	.03	-.13	**-.21****	-.06	.03	-.09	-.05	**.25****	**.18****	.05	.03	.09
29. Time spent listening to music	.04	.08	.08	.07	-.09	-.02	.00	.08	.01	**.15***	.04	.11	.11	**.17***

*Note: RH = Reading Habits; CRH= Comparative Reading Habits; RT = Reading Time; ART= Author Recognition Test; *p*<.05; **p*<.01*

Table 2.8
Continued

	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
1. RH Number of books read in a year															
2. RH Frequency of bookstore visits															
3. RH Frequency of online bookstore visits															
4. RH Number of books in family home															
5. CRH Time spent reading academic material															
6. CRH Time spent reading fiction															
7. CRH Time spent reading newspapers and magazines															
8. CRH Complexity of non-academic material															
9. CRH Enjoyment of reading															
10. CRH Time spent on social media															
11. RT Time spent reading textbooks															
12. RT Time spent reading academic material															
13. RT Time spent reading fiction															
14. RT Time spent reading non-fiction/special interest															
15. RT Time spent reading graphic novels															
16. RT Time spent reading magazines	**.15***														
17. RT Time spent reading newspapers	.13	**.16***													
18. RT Time spent reading e-mail	**.16***	**.15***	**.20****												
19. RT Time spent reading content on social media	.02	**.16***	-.05	**.22****											
20. RT Time spent reading internet media	**.14***	**.30****	.05	.12	**.23****										
21. ART	-.08	-.08	.07	-.01	-.04	.12									
22. Time spent talking with friends	.05	-.08	-.07	.08	.13	.09	.01								
23. Time spent talking with family	-.01	**.19****	.04	.11	**.18****	**.17***	-.02	-.01							
24. Time spent watching TV shows	-.02	.02	-.10	-.06	.11	.06	.02	.13	.03						
25. Time spent watching online video clips	**.16***	-.01	.02	-.06	.11	**.22****	-.03	**.14***	.02	**.27****					
26. Time spent talking on internet media	**.14***	.06	.03	.09	**.21****	**.22****	**-.13***	-.02	**.26****	.07	**.29****				
27. Time spent on online messaging	.02	.07	-.06	.01	**.38****	**.14***	-.03	**.24****	.13	**.35****	**.23****	**.32****			
28. Time spent texting	.03	.12	.00	.12	**.33****	**.18****	-.06	**.20****	**.20****	**.16***	.11	**.23****	**.41****		
29. Time spent listening to music	.08	-.07	.03	-.05	.11	.06	.01	**.25****	-.09	.02	**.20****	.07	**.24****	**.21****	

*Note: RH = Reading Habits; CRH= Comparative Reading Habits; RT = Reading Time; ART= Author Recognition Test; *p*<.05; **p*<.01*

2.3.2.3 Factor Analysis of Language Exposure Items

To further explore the relationships between measures of print and spoken language exposure, an exploratory factor analysis was conducted.

The inter-item correlations presented previously suggest that items are related in complex ways in this study. In order to assess which measures group together, data for all variables were transformed into *z* scores and an Exploratory Factor Analysis (EFA) was performed. Combining the result of the scree plot and eigenvalues, five factors were extracted, which in combination, accounted for 41.41% of the variance in the data. The KMO result of 0.73 suggested that the sampling is adequate and a significant Bartlett's test showed variables are unrelated, presenting that the data is suited to factor analysis. Table 2.9 presents the factor loadings of a principal component analysis after varimax rotation.

The items that cluster on the same factor suggest that factor 1 represents *recreational reading* due to high loadings of enjoyment of reading, frequency of bookstore visits, and number of books read in a year. Factor 2 captures a component of *communication and social media use* due to time spent on social media, online messaging, and texting loading highly on this factor. Factor 3 captures *reading for academic purposes*, due to the factor containing time spent reading academic material and textbooks. Factor 4 includes email and time spent reading newspapers, suggesting this factor represents *information exposure*. Lastly, factor 5 represents *accessibility of reading material*, due to high loadings of the ART and number of books in the family home. This is a surprising result as previous studies, such as Acheson et al. (2008), have found the ART to load onto factors with other measures of reading habits, such as the CRH items. The alpha statistic shows that internal reliability for this factor was low (α

= .11), compared to the other factors, which could suggest poor interrelatedness between items.

Since Acheson et al.'s (2008) study, a selection of studies have also used the CRH measure along with other reading measures. It was found in a number of these studies, including Acheson et al. (2008), that when entering comparative reading habits into a factor analysis, the contribution of other self-reported reading measures became non-significant (Acheson et al., 2008; Chen & Fang, 2015; Choi, Lowder, Ferreira, & Henderson, 2015). However, these previous studies used CRH as a composite score. As the current study was assessing how different aspects of language exposure relate to other variables, such as SES, it was important to consider the CRH measure as individual variables. The reason for this was that the CRH measures includes various types of materials, including academic reading and fiction reading. Results showed that when entered into a factor analysis as individual variables, the CRH variables were shown load onto separate factors, with fiction reading loading onto factor 1 and academic reading loading onto factor 3.

To summarise, the EFA presented five distinct factors within the data, namely *recreational reading*, *communication and social media use*, *reading for academic purposes*, *information exposure*, and *accessibility to reading material*.

Table 2.9
Principal Component Analysis After Varimax Rotation

Variable	Factor				
	1	2	3	4	5
RH Number of books read in a year	**.84**	.01	.07	.02	.11
CRH Time spent reading fiction	**.83**	.02	-.08	-.15	.08
RT Time spent reading fiction	**.82**	.06	-.04	.07	.07
CRH Enjoyment of reading	**.75**	-.04	.12	.00	.06
RH Frequency of bookstore visits	**.60**	-.26	.10	.21	.19
RH Frequency of online bookstore visits	**.59**	-.05	.24	.26	-.11
RT Time spent reading content on social media	-.06	**.70**	.13	.15	.07
Time spent on online messaging	.13	**.66**	-.15	-.11	.14
CRH Time spent on social media	-.11	**.64**	-.09	-.24	.05
Time spent texting	-.00	**.62**	-.00	.21	-.14
RT Time spent reading internet media	.06	**.43**	.04	.05	.17
Time spent talking with family	-.06	**.42**	.13	.24	-.17
Time spent talking on internet media	.06	**.46**	.07	.06	**-.47**
RT Time spent reading academic material	.04	.03	**.74**	.04	.22
RT Time spent reading textbooks	.03	.19	**.67**	-.06	-.19
CRH Time spent reading academic material	.20	-.19	**.63**	.09	.18
RT Time spent reading newspapers	.11	-.05	-.14	**.73**	.01
RT Time spent reading e-mail	.03	.07	.16	**.72**	-.03
ART	.19	-.01	.07	.07	**.69**
RH Number of books in family home	.27	-.03	.11	-.22	**.54**
CRH Time spent reading newspapers and magazines	-.09	.22	-.27	.37	**.43**
CRH Complexity of non-academic material	.22	-.16	.09	.08	.14
RT Time spent reading non-fiction/special interest	.27	.01	.10	.22	.08
RT Time spent reading magazines	-.18	.22	-.11	.26	.17
RT Time spent reading graphic novels	.21	-.12	.00	-.02	-.18
Time spent talking with friends	-.02	.17	-.23	.17	.11
Time spent watching online video clips	.03	.21	-.20	-.15	-.26
Time spent listening to music	.04	.21	.10	-.10	.02
Time spent watching TV shows	-.51	.38	-.38	-.23	.12
Eigenvalues	3.75	2.83	1.96	1.83	1.64
% of variance	12.93	9.77	6.77	6.29	5.64
α	.86	.70	.56	.52	.11

Note: RH = Reading Habits; RT = Reading Time; CRH= Comparative Reading Habits; ART = Author Recognition Test

2.3.2.4 Test-retest Reliability of Language Exposure Items

To assess test-retest reliability of the language exposure measures, 14 participants from the total sample completed the language exposure measures twice, with approximately one week between testing sessions. Table 2.10 shows test-retest

correlations for the language exposure measures. A high test-retest reliability was found for the reading habits items, and the CRH items, excluding CRH academic material and CRH complexity. The updated version of the ART shows good test-retest reliability (*r*=.87) along with most of the reading time items, apart from time spent reading magazines and newspapers.

Overall, the majority of the items that measure written language exposure show moderate to high test-retest reliability. On the other hand, the spoken language exposure items show less reliability. This could suggest that it is challenging to capture spoken language exposure through a questionnaire measure, as it may be difficult for respondents to accurately estimate how much time they spend listening to and communicating using spoken language each week, which may also fluctuate week to week.

Table 2.10

Correlation Coefficients for Test-retest Reliability of Language Exposure Items

Item	*R*
Reading Habits	
Number of books read in a year	.97**
Frequency of bookstore visits	.92**
Frequency of online bookstore visits	.75**
Number of books in family home	.90**
Comparative Reading Habits	
CRH Time spent reading academic material	.51
CRH Time spent reading fiction	.94**
CRH Time spent reading newspapers and magazines	.84**
CRH Complexity of non-academic material	.42
CRH Enjoyment of reading	.94**
CRH Time spent on social media	.87**
Reading Time	
Time spent reading textbooks	.83**
Time spent reading academic material	.55*
Time spent reading fiction	.98**
Time spent reading non-fiction/special interest	.74**
Time spent reading graphic novels	.68*
Time spent reading magazines	.31
Time spent reading newspapers	.01
Time spent reading e-mail	.86**
Time spent reading content on social media	.60*
Time spent reading internet media	.73**
Author Recognition Test	
ART	.87**
Spoken Language Exposure	
Time spent talking with friends	-.62*
Time spent talking with family	-.23
Time spent watching TV shows	-.26
Time spent watching online video clips	.13
Time spent talking on internet media	.31
Time spent on online messaging	.21
Time spent texting	.66*
Time spent listening to music	-.71**

*Note: CRH= Comparative Reading Habits; ART= Author Recognition Test; *p*<.05; **p*<.01*

2.3.3 Sentence Familiarity Rating Tasks

2.3.3.1 Descriptive Statistics of Sentence Structure Familiarity Tasks

Table 2.11 presents descriptive statistics for the individual sentence familiarity rating task. When comparing mean familiarity scores of subject-first and object-first structures, it is clear that sentences that follow a subject-first word order are rated as

more familiar than sentences that follow an object-first word order. This reflects the structure of the English language as approximately 90% of sentences are subject-first, as found in written and spoken corpora (Roland et al., 2007). With regards to relative clauses, object-first sentences, including ORCs and PRCs, occur up to 70 percent of the time in both BNC written and BNC spoken corpora, with subject-first relative clauses (SRCs) making up the rest of the data (Roland et al., 2007). Therefore, if this familiarity task is indirectly measuring frequency of structures, then mean familiarity should be higher for object-first relative clauses because they are more frequent in language. However, this is not the case; SRCs have a higher mean familiarity rating than both ORCs and PRCs, except for reduced ORCs.

Descriptive statistics for the comparative familiarity rating task are shown in Table 2.12. As can be seen from the mean score for each structure, active sentences, classified as simple transitives, were rated as more familiar than passives. Within the corpus data, simple transitives have a slightly higher frequency than passives, and so this result is not surprising. Similarly, ORCs were rated more familiar than PRCs, which only reflects the spoken corpus data, but not the written corpus data (Roland et al., 2007). Interestingly, there is a larger difference in mean familiarity between ORCs and PRCs in the comparative rating task, compared to when structures are rated individually.

Table 2.11
Descriptive Statistics for the Items in the Individual Familiarity Rating Task

Item	Example sentence	Mean (S.D.)	Range	Median	Skewness	Kurtosis
Subject-first Word Order						
WH clause *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	She couldn't remember where the party was.	6.21 (0.72)	3 (4-7)	6.5	-0.85	0.42
Simple intransitive *(as previous item)*	The money disappeared.	6.14 (0.94)	5.5 (1.5-7)	6.5	-1.67	4.08
Simple transitive *(as previous item)*	The fireman carried the hose.	6.12 (0.85)	5 (2-7)	6.0	-1.42	3.30
Prepositional phrase *(as previous item)*	The waitress drove to the restaurant.	6.10 (0.94)	6 (1-7)	6.0	-1.50	3.81
Perception complement *(as previous item)*	Alex heard the bells ringing.	6.07 (0.91)	4.5 (2.5-7)	6.0	-1.05	1.08
Transitive and WH clause *(as previous item)*	I asked what the assistant wanted.	6.00 (0.86)	5 (2-7)	6.0	-1.14	2.21
Ditransitive *(as previous item)*	He read his son the book.	5.98 (0.86)	6 (1-7)	6.0	-1.37	4.62
Transitive and prepositional phrase *(as previous item)*	Jack pulled the ball out of the pond.	5.74 (1.02)	5.5 (1.5-7)	6.0	-0.89	1.24
Sentential complement (without complementiser) *(as previous item)*	Ruby hoped the shop was open.	5.71 (0.97)	5.5 (1.5-7)	6.0	-1.03	1.72
Subject infinitive relative clause *(as previous item)*	The next contestant to answer correctly will win a prize.	5.67 (1.09)	5 (2-7)	6.0	-0.98	0.72
Transitive and to infinitive verb phrase *(as previous item)*	The receptionist advised us to wait.	5.54 (1.05)	5 (2-7)	5.8	-0.77	0.69
Subject relative clause *(as previous item)*	The man who wrote the book was a surgeon.	5.53 (1.06)	6 (1-7)	5.5	-1.05	1.93
To Infinitive verb phrase *(as previous item)*	The runner tried to achieve her goal.	5.53 (0.96)	4.5 (2.5-7)	5.5	-0.42	-0.04
Sentential complement (with complementiser) *(as previous item)*	The father accepted that his daughter was getting married.	5.41 (1.04)	6 (1-7)	5.5	-0.60	0.68

Note: S.D = Standard Deviation

Table 2.11
Continued

Item	Example Sentence	Mean (S.D.)	Range	Median	Skewness	Kurtosis
Object-first Word Order Object relative clause (reduced) *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The toy she wanted was expensive	5.95 (0.82)	4 (3-7)	6.0	-0.77	0.72
Passive *(as previous item)*	Janet was paid by a local company.	5.38 (0.98)	4.5 (2.5-7)	5.5	-0.09	-0.54
Passive relative clause (reduced) *(as previous item)*	The actress mentioned by the journalist was famous.	4.97 (1.21)	5.5 (1.5-7)	5.0	-0.50	0.03
Passive infinitive relative clause *(as previous item)*	The issue to be discussed at the meeting is very important.	4.85 (1.19)	5.5 (1.5-7)	5.0	-0.41	-0.29
Object relative clause *(as previous item)*	The pride that the winner felt was overwhelming.	4.75 (1.16)	5 (2-7)	5.0	-0.09	-0.54
Passive relative clause *(as previous item)*	The object that was found by the archaeologist was unusual.	4.57 (1.16)	5.5 (1.5-7)	4.5	-0.16	-0.20
Object infinitive relative clause *(as previous item)*	The equation to learn for Tuesday is on page 3.	3.61 (0.85)	5 (1-6)	3.5	-0.30	0.80

Note: S.D = Standard Deviation

Table 2.12
Descriptive Statistics for the Items in the Comparative Familiarity Rating Task

Item	Example Sentence	Mean (S.D.)	Range	Median	Skewness	Kurtosis
Active *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The organisers described the event.	5.58 (0.66)	4.3 (2.7-7)	5.62	-0.14	-0.10
Passive *(as previous item)*	The event was described by the organisers.	4.57 (0.73)	4.2 (2.3-6.7)	4.56	0.04	0.05
Passive relative clause *(as previous item)*	The planet that was hit by the asteroid contained life.	4.04 (0.77)	4.2 (1.7-5.9)	4.00	0.18	-0.39
Object relative clause *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The planet that the asteroid hit contained life.	5.33 (0.58)	3.7 (3-6.7)	5.33	-0.22	0.33
Ditransitive *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The teacher gave the students a test. The teacher gave a test to the students.	5.27 (0.62)	4.5 (2.5-7)	5.25	0.18	-0.40

Note: S.D = Standard Deviation

2.3.3.2 Validation of the task as a measure of sentence structure familiarity

As this task assumes that an individual's familiarity with a syntactic structure is related to the amount of exposure the individual has with that structure, its validity must be assessed against established previous research. Validation of this task was assessed using Roland et al.'s (2007) corpus data for frequency of syntactic structures in written and spoken language. Therefore, a direct comparison can be made between each structure's frequency in written and spoken language, and the corresponding familiarity rating. If the task is measuring familiarity, it would be expected that the structures that appear more frequently in language would be rated as more familiar than those less frequent.

Scatterplots showed a positive relationship between structure frequency in the BNC written and BNC spoken corpora and mean familiarity ratings for the whole sample (N=224); therefore, correlations were reviewed to see if this relationship was significant. Table 2.13 shows correlations between mean familiarity rating in the individual rating task and frequency of structures within both written and spoken language, as indicated in corpus data (Roland et al., 2007). These correlations show a small yet significant relationship between mean familiarity rating and frequency in spoken language, but no significant relationship with frequency in written language. Furthermore, Table 2.14 shows a similar pattern for the mean familiarity rating of the five types of sentences present in the comparative rating task. This could indicate that the two rating tasks developed in this study are better at capturing familiarity of sentences present in spoken language rather than written language, and possibly, indirectly capturing an individual's exposure to the types of sentences present in spoken language.

Table 2.13
Correlations between Mean Familiarity Rating in the Individual Rating Task and Corpus Data of Structure Frequency

	1.	2.	3.
1. Mean familiarity rating			
2. Frequency in written language	.02		
3. Frequency in spoken language	.11**	.79**	

*Note: **p<.01*

Table 2.14
Correlations Between Mean Familiarity Rating in the Comparative Rating Task and Corpus Data of Structure Frequency

	1.	2.	3.
1. Mean familiarity rating			
2. Frequency in written language	-.02		
3. Frequency in spoken language	.24**	.60**	

*Note: **p<.01*

2.3.3.3 Analysis of Sentence Structures

In order to assess whether more frequent structures, that follow a subject-first word order, are rated as more familiar than complex structures, such as object-first structures, several t-test analyses were conducted.

Individual task

When a t-test was conducted, the difference in the familiarity rating between subject-first and object-first structures was found to be significant ($t(221) = 24.81$, $p<0.01$). This suggests that individuals in this sample rated subject-first sentences as more familiar, suggesting that they encounter subject-first structures more often in language than object-first structures.

Comparative task

In order to test whether there was a statistically significant difference in the rating between different structures in the comparative rating task, t-test analyses were

conducted. On average, active sentences were rated as more familiar (*M*= 5.58, *SD*= 0.66) than passive sentences (*M*= 4.57, *SD*= 0.73). This difference was significant ($t(229) = 17.24$, $p<0.01$). Similarly, there was a significant difference in familiarity rating between PRCs and ORCs ($t(229) = 17.24$, $p<0.01$), with ORCs being rated as more familiar (*M*= 5.33, *SD*= 0.58) than PRCs (*M*= 4.04, *SD*= 0.77).

Comparison of the two tasks

The aim of the following analyses was to assess if the familiarity rating of a structure changes depending on the task. Both passive and ORC structures were used in both the individual rating task and the comparative rating task. Within this, some sentences were repeated in both tasks. In the individual rating task, the sentences were presented individually, whereas in the comparative rating task, the sentences were presented with the alternative counterpart. These sentences had the same structures and meaning in both tasks, and therefore the familiarity rating can be directly compared, with only the task context changing. The analyses showed a significant difference in familiarity between tasks for all repeated sentences. Table 2.15 shows the t-test result for each sentence. In general, these sentences were rated as less familiar in the comparative rating task when they were presented with their counterpart.

Table 2.15

Means for sentences in each task, along with t-test analyses to compare statistical significance in ratings between tasks

Structure	Sentence	Mean (s.d.) [a]		*t*
		Individual Task	Comparative Task	
Passive	The event was described by the organisers.	4.88 (1.36)	3.83 (1.49)	-8.41**
Passive	Janet was paid by a local company.	5.87 (1.06)	5.63 (1.15)	-2.81**
ORC reduced	The toy she wanted was expensive.[b]	6.09 (0.82)	2.39 (1.29)	-34.68**
ORC	The pride that the winner felt was overwhelming.	5.24 (1.31)	5.57 (1.28)	3.19**
PRC reduced	The student chosen by Mr Hart passed the exam.	5.01 (1.43)	4.57 (1.42)	-3.95**
PRC reduced	The actress mentioned by the journalist was famous.	4.92 (1.34)	4.50 (1.53)	-3.37**
PRC	The object that was found by the archaeologist was very unusual.	4.88 (1.42)	4.17 (1.51)	-5.82**
PRC	The award that was expected by Professor West was very prestigious.	4.27 (1.50)	2.83 (1.27)	-13.21**

Note: p<.01; s.d.= Standard Deviation; [a] Familiarity rating scale range= 1-7; [b] This sentence was changed when used in the comparative rating task due to the need for a counterpart with the same meaning to 'The toy the child wanted was expensive'

2.3.3.5 Test-retest Reliability of Sentence Structure Familiarity Tasks

Fourteen participants completed both familiarity rating tasks twice for test-retest purposes. Test-retest reliability was .85 for the individual rating task, and .75 for the comparative rating task. This shows that both tasks have good test-retest reliability.

2.4 Discussion

The main purpose of this study was to develop a series of measures of written and spoken language exposure to be used in subsequent studies assessing key relationships between SES, language exposure, and language processing in young adults.

In the current study, SES was measured using indicators of mother's and father's education and occupation, and household income. While the sample was recruited from a university community, it included participants from a wide range of SES backgrounds (as shown in Appendix 3). The indicators of SES were weak to moderately intercorrelated and were grouped as a composite score, as has been done in previous studies. Consequently, the following studies will utilise these measures when assessing SES.

These indicators are classified as family SES measures, which are the common measures of SES in children (Shavers, 2007), yet are rarely used in adult studies as adults can report their own income, occupation and education. In the current study, most the sample consisted of university students who have not yet finished education, and thus do not have a stable occupation or income. As a result of this and paired with a lack of SES measures specifically to assess young adults, familial SES was used.

A series of measures were developed or adapted from previous research to assess different aspects of language exposure. To assess written language exposure four measures were used. Firstly, the Reading Habits section measured number of books an individual reads in a year, frequency of bookstore visits and number of books in the home. The second measure assessed Comparative Reading Habits of different types of materials including academic material, fiction, newspapers and magazines, as well as complexity of reading material and enjoyment of reading, compared to peers. An additional question was added to ask about reading content on social media compared to peers. Third, a Reading Time measure asked about how much time an individual spends reading different types of material including textbooks, academic material other than textbooks, fiction books, non-fiction/special interest books, graphic novels, magazines, newspapers, e-mail, reading content on social media, and internet media. The final measure of written language exposure was an updated version of the ART (Stanovich & West, 1989).

To assess spoken language exposure, one measure was adapted from the LEAP-Q (Marian et al., 2007). The measure asked participants to indicate how much time they spend in different spoken language contexts, including talking with friends and family, watching TV, watching online video clips, internet media (such as online forums), online messaging, texting, and listening to music with lyrics.

Correlational analyses of the written language exposure measures showed that items within each section were weak to moderately intercorrelated, which is similar to the results found in the original studies that have used these measures (Acheson et al., 2008; Stanovich & West, 1989). The results also showed weak intercorrelations for the spoken language items. No significant correlations were found between the measures of written and spoken language exposure, with the exception of CRH reading content

on social media and the spoken language items. This could suggest that social media encompasses aspects of spoken language as well as written language. This could be through activities such as online messaging which had the strongest relationship with CRH reading content on social media (r=.32), compared to the other spoken language items.

The ART, an indirect measure of fiction reading, correlated with other written language exposure items, such as number of books in the home, frequency of bookstore visits, comparative enjoyment of reading, and reading time of fiction books. This supports previous research that has shown moderate relationships between the ART and comparative reading habits and reading time (Acheson et al., 2008).

There was a clear dissociation found between reading academically and non-academically, which has also been found in previous research (Acheson et al., 2008; Sheorey & Mokhtari, 1994). For example, measures of CRH academic material and Reading Time estimates of textbooks and academic material were significantly correlated, and CRH fiction and CRH enjoyment of reading correlate highly with time spent reading fiction. However, these academic and non-academic items were not significantly correlated with one another.

Unlike previous studies, a composite measure was not created for each section, but rather all variables were entered into a factor analysis individually. This was to investigate whether items in different measures fit together with items analysing similar aspects of language.

Further analyses of the language exposure measures demonstrated that they are underpinned by five distinct factors of exposure. The factors included *recreational reading*, *communication and social media use*, *reading for academic purposes*, *information exposure,* and *accessibility of reading material*.

A surprising finding was that the ART did not load onto the first factor, which represented *recreational reading*, along with time spent reading fiction, enjoyment of reading, and frequency of bookstore visits, although significantly correlating with these variables. While the ART does not load onto this factor as may be expected, this could suggest that the ART does not measure amount of reading per se, but exposure to reading materials such as through the number of books in the home. This might also be why CRH newspapers and magazines fit with this factor, because of exposure to this type of reading material in the home.

After finding weak correlations between items within the spoken language measure, it is not surprising that a separate spoken language factor was not found. Instead, only some of the spoken language variables loaded onto factor 2, which represented *communication and social media use*, such as time spent talking with family and online messaging. The other four factors did not include any spoken language variables and covered written language exposure only. An interesting finding is a large negative loading of time spent watching TV shows on factor 1. Although this finding is non-significant, it shows a clear dissociation between the activities of reading and watching TV. This result supports previous research which has found that digital media, including watching TV, often displaces reading for pleasure in adolescents and young adults (e.g. Levine, Waite, & Bowman, 2007; Twenge, Martin, & Spitzberg, 2019).

In addition to the adapted measures of written and spoken language exposure, the sentence structure familiarity rating tasks were designed as a novel way to indirectly measure exposure to language, specifically grammar, through subjective familiarity of a range of syntactic structures. Corpus data of frequency of syntactic structures in written and spoken language was used to guide the development of the two tasks

(Roland et al., 2007). Therefore, if these tasks are a valid measure of familiarity, then familiarity should reflect frequency of structures in language. Highly frequent structures should be rated as more familiar than less frequent structures. The results showed that there was a significant difference in the ratings between subject-first and object-first structures, showing subject-first structures, which are more frequent in language, were rated as more familiar than object-first structures. To further explore this result, familiarity data was correlated with frequency data from Roland et al. (2007). These analyses confirmed that the new tasks captured broader sentence structure frequency in the language. However, the correlations were weak, and were constrained to spoken corpora. Thus, as both familiarity tasks correlated with the corpus data for frequency of structures in spoken language, it is possible that the tasks are indirectly measuring exposure to the types of structures present in spoken language more than written language.

In addition to these findings, test-retest correlations were conducted on the adapted and newly developed measures, which included the written and spoken language exposure items, and the sentence familiarity rating task. This showed good reliability for the written language exposure measures, including high test-retest reliability for the updated ART measure. Therefore, the guidelines set out in Moore and Gordon (2015) proved useful for reliably updating the ART. Furthermore, both sentence familiarity rating tasks showed high test-retest reliability results. The spoken language exposure items generally showed low reliability, suggesting weaknesses in this measure as a way to assess spoken language exposure in this sample. It is also possible that there is more variability in spoken than written language exposure over time. This finding warrants further studies.

In summary, a series of measures of written and spoken language exposure were developed to be used in subsequent studies assessing key relationships between SES, language exposure, and language processing in young adults. This included a composite measure of SES, composite scores of written and spoken language exposure, created following the exploratory factor analysis, and the newly created sentence structure familiarity rating task. The following chapter uses the same sample of participants as presented above to assess the main research questions.

Chapter 3: Relationship between SES, Language Exposure, and Receptive and Expressive Grammar in Young Adults

3.1 Introduction

The study presented in Chapter 3 uses the measures developed in Chapter 2 to investigate three constructs of interest: socio-economic status (SES), language exposure, and offline language processing, in young adults. The same sample of participants were used, as in Chapter 2, for the following study.

It is well established in the literature that SES is strongly related to variations in language development (e.g. Hoff, 2006; Rowe & Weisleder, 2020). The language input experienced in the home can lay foundations for language development as children progress through education (Weisleder & Fernald, 2013). This language input can occur through spoken and written language, including interaction with parents, and shared book reading. At a group level, parents from high SES (HSES) families produce more child-directed speech than parents from low SES (LSES) families. An influential study in this area showed a substantial difference in the amount of child-directed speech heard by children in different SES groups: children from HSES groups were exposed to, on average, 32 million words more than LSES children by the age of 3 (Hart & Risley, 1999). Rowe (2008) recorded child-directed speech in the home and found that the amount of child-directed speech was related to parental SES, in that children from a HSES family heard more child-directed speech than children from LSES.

Parent-child interaction, encompassing child-directed speech, has been widely researched in relation to language development (see Hoff, 2006, for a review). Child-directed speech with children aged two years old, predicted the vocabulary knowledge of children one year later (Rowe, 2008). More recently, Fernald and colleagues (Fernald, Marchman, & Weisleder, 2013) found large disparities in language

processing efficiency between children from HSES and LSES backgrounds as early as 18 months old, as a result of the language heard in the home. This research demonstrates the influence of SES on the language input that children receive, and also the influence of SES on language use as reflected in both vocabulary knowledge and online processing. This evidence indicates that the early years are a crucial time for building the foundations for language.

In addition to spoken language exposure, as children begin to read, they are exposed to a wide range of language that is present in written texts. In a study comparing the language in children's picture books and child-directed speech, Montag, Jones and Smith (2015) found that picture books, aimed at young children unable to read and therefore require shared book reading by a parent, included a more diverse vocabulary range than child-directed speech. The analysis of picture book and child-directed speech corpora showed that there were 1.72 times more unique words in picture books. Beyond differences in vocabulary diversity, corpus studies have also found that written language contains other important aspects relevant for language development, such as a larger diversity of grammar (Montag & MacDonald, 2015; Roland, Dick, & Elman, 2007). Again looking at picture books, Montag (2019) found that complex sentences, including passives and object relative clauses, were significantly more frequent in picture books than child-directed speech. This suggests that language input through book reading may influence differences in language skills due to the higher quantity of less frequent language.

English has a standard word order of subject-verb-object (SVO, Akhtar, 1999). Therefore, a frequent sentence structure would follow the SVO word order, such as the *the boy helped the girl*. A sentence that does not follow this word order is less frequent in language, such as *the girl that the boy helped was happy*, which has a word order of

object-subject-verb (OSV). Less frequent structures are found more in written language compared to spoken language (Roland et al., 2007). Therefore, it can be assumed that the more an individual reads, the more they will encounter less frequent sentence structures.

The current study explores written and spoken language exposure and whether it relates to language processing in young adults. Previous studies have consistently found significant relationships between measures of print exposure and language skills (see Mol & Bus, 2011, for a review). In a meta-analysis of studies which assessed the relation of print exposure to language and reading skills from pre-school age to young adults, Mol and Bus (2011) found that print exposure significantly related to vocabulary knowledge at pre-school age, with a linear growth of effect sizes throughout childhood and into adulthood. Other studies have shown that more print exposure, specifically for book reading, predicted better language comprehension in later childhood and adolescence (Torppa et al., 2020). These relationships have been found in both children and young adults concerning vocabulary knowledge (e.g. Cunningham & Stanovich, 1991), and grammar (e.g. James, Fraundorf, Lee, & Watson, 2018; Montag & MacDonald, 2015; Wells, Christiansen, Race, Acheson, & MacDonald, 2009).

The main aim of the current study is to examine individual relationships between elements of three key constructs; SES, language exposure and language processing, in young adults. In Chapter 2, a series of measures were developed to assess SES and written and spoken language exposure. In the current chapter, standardised measures were used to assess offline language processing, including vocabulary and expressive and receptive grammar. The sample of participants that were presented in Chapter 2 to pilot the newly developed measures were also used for the following analyses. Three relationships will be examined: (1) the relationship between SES and

language exposure using the measures of these two constructs presented in Chapter 2, (2) the relationship between SES and offline language processing, and (3) the relationship between language exposure and offline language processing.

Additionally, an exploratory analysis will investigate whether there is a relationship between language exposure and ratings of sentence structure familiarity, comparing both simple and complex structures that exist in the English language. Previous research has found that some sentence structures are more frequent in written language compared to spoken language (Montag & MacDonald, 2015; Roland et al., 2007). This analysis aims to investigate whether exposure to the structures in written and spoken language relates to familiarity of these syntactic structures. Therefore, it is possible that an increased familiarity of these structures relates to better performance on standardised vocabulary and grammar tests, and improved language processing.

3.2 Method

3.2.1 Participants

The results presented in this chapter were based on the sample outlined in the previous chapter. The final sample included 224 participants (47 males, 177 females) aged 18 to 29 years (M = 20.66, SD = 2.25) who reported having no reading or language difficulties and speaking English as their first language. Fifty participants completed the SES, language exposure and sentence structure familiarity rating tasks online remotely, and the remaining 174 participants completed these tasks and the additional standardised tests in a laboratory setting. The data presented below therefore include 224 participants for the measures of SES, language exposure and sentence structure familiarity rating tasks, and 174 participants for the measures of language use.

3.2.2 Measures

3.2.2.1 Measures of SES and Language Exposure

In order to assess SES and exposure to written and spoken language, the newly developed set of measures presented in Chapter 2 was used. This included commonly used indicators of SES: parental education, parental occupation, and household income. The measures of written language exposure included: the updated ART, the Reading Habits measure assessing book reading experiences, the Reading Time measure assessing the time spent reading different type of materials (e.g. fiction, non-fiction, academic and non-academic readings, as well as content on internet and social media), and the Comparative Reading Habits measure assessing written language exposure relative to peers. Spoken language exposure was assessed using an adapted version of the LEAP-Q (Marian, Blumenfeld, & Kaushanskaya, 2007). Additionally, the newly developed sentence structure familiarity rating tasks were used to assess an individual's exposure to different types of English sentence structures.

3.2.2.2 Offline Language Processing Measures

Vocabulary: The vocabulary subtest from the Wechsler Abbreviated Scale of Intelligence - Second Edition (WASI-II: Wechsler, 2011) was included in this study. Participants were required to orally define a list of 28 words while the researcher recorded the answers verbatim. The correct definition of each word is awarded a score of one or two points depending on the detail and accuracy of the answer given. Incorrect responses are not awarded any points. Participants' answers were queried if responses were too general, and if possible, participants were asked to give more detail. The maximum score for this subtest is 59. Scoring was discontinued after three consecutive incorrect responses. Scaled scores for this task were used in the subsequent analyses.

The WASI-II vocabulary subtest is standardised for participants aged six to 89 years. Wechsler (2011) reported good interrater reliability (*r*= .98) and split-half reliability (*r*= .90) for the vocabulary subtest. An example of this test can be found in Appendix 17.

Receptive grammar: The Test for Reception of Grammar – Second Edition (TROG-2: Bishop, 2003) was used to assess offline grammar use via language comprehension. The test requires participants to listen to an orally presented sentence and choose, from an array of four pictures, the picture that represents the relationship being described. All pictures in the array include plausible events, but only one picture displays the relationship being discussed.

For example, a sentence such as *the cup is in the box* would be read aloud to participants and they would see an array of the following pictures: (1) a cup next to a box; (2) a cup in a box; (3) a box in a cup; and (4) a cup on top of a box. An example of this test can be found in Appendix 28. Eighty sentences are included in this test, split into blocks of four. The four sentences in a block follow one grammatical structure, and each block focuses on a different grammatical structure, which increases with complexity throughout the test; this ranges from simple structures, such as *reversible in and on*, to complex structures such as *centre-embedded sentences*. One point is awarded if all four sentences in a block are answered correctly, giving the test a total score of 20. The test is discontinued if five consecutive blocks are answered incorrectly; however, there was no session in which this happened. Scaled scores for this task were used in the subsequent analyses. The TROG-2 is standardised for participants aged four years to adult and has reported good internal consistency (*r*= .88), indicating a high level of reliability (Bishop, 2003).

Expressive grammar: The Sentence Combining subtest within the Test of Adolescent and Adult Language – Fourth Edition (TOAL-4: Hammill, Brown, Larsen, & Wiederholt, 2007) was used to assess offline grammar use via language production. The test requires participants to combine two or more individual sentences into one grammatically correct sentence, while maintaining all important details. To give an example, the sentences to be combined could be *Ann wears rings. The rings are on her fingers. The rings are pretty.* The resulting sentence could be *Ann wears pretty rings on her fingers.* Thirty questions are included in the test, and each question includes between two and six sentences to be combined. The total score for this test was 30, with each correct answer scored one point. Standard scores were used in the subsequent analyses. The TOAL-4 is standardised for participants aged 12 to 24.11 years. Internal consistency for the TOAL-4 adult sample ranged from .87 to .92, showing good reliability (Hammill et al., 2007). An example of the expressive grammar test can be found in Appendix 29.

Non-verbal IQ: A second subtest from the WASI-II was used that assessed non-verbal IQ: matrix reasoning. The reason for including a test of non-verbal IQ was to validate the measures of language use. The matrix reasoning subtest involves showing an incomplete picture matrix or series and asking participants to choose from a selection of five pictures in order to complete the pattern. Each correct answer is scored one point, and the maximum score for this subtest is 30. Scoring is discontinued after three consecutive incorrect responses. Scaled scores were used in the subsequent analyses. The WASI-II test is standardised for participants aged six to 89 years. The matrix reasoning subtest was reported to have strong psychometric properties, including excellent split-half reliability (r= .92; Wechsler, 2011). An example of this subtest can be found in Appendix 30.

3.2.3 Procedure

Each participant that took part in the laboratory completed the study in a single testing session, which took approximately 60 minutes. Participants were seated at a computer and asked to complete a consent form and answer demographic questions (e.g. gender, date of birth, native language). The SES and language exposure measures were completed first. They were presented together on the Qualtrics online survey platform. Following this, four standardised tests were completed in the following order: non-verbal IQ, expressive grammar, vocabulary knowledge, and receptive grammar. The order of the tasks was the same for each participant in order to minimize experiment variability. At the conclusion of the study, each participant was invited to return to complete a retest of the questionnaire.

3.3 Results

The following section assesses the relationships between SES and measures of written and spoken language exposure, SES and offline language use measured using standardised tests of vocabulary and grammar, and the relationship between measures of language exposure and offline language processing. An exploratory analysis of the relationship between sentence structure familiarity ratings and standardised tests of grammar is also presented.

To assess SES, a composite measure was developed using mean scores for the parental education, parental occupation, and household income measures. To assess language exposure, factor scores were used based on the factor analysis of the written and spoken language exposure measures presented in Chapter 2. The factors included *Recreational Reading*, *Communication and Social Media Use*, *Reading for Academic Purposes*, *Information Exposure*, and *Accessibility of Reading Material*.

3.3.1 Descriptive Statistics for the Offline Language Processing Measures

Table 3.1 shows descriptive statistics for the standardised scores on the offline measures of vocabulary and grammar, and non-verbal IQ. As can be seen, mean scores were moderately high for receptive grammar and expressive grammar, yet medium for vocabulary knowledge. The distributions for all measures were normal.

Table 3.1
Descriptive Statistics of the Standardised Scores for the Offline Measures of Language Use (N=174)

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Vocabulary knowledge [1]	10.35 (2.32)	11 (2-19)	-.43	1.93
Receptive grammar [2]	98.12 (8.02)	99 (67-109)	-1.09	1.64
Expressive grammar [1]	10.31 (2.61)	10 (1-15)	-.31	-.10
Non-verbal IQ [1]	10.05 (2.76)	10 (3-19)	.41	1.44

Note: s.d. = Standard Deviation; [1]Scaled score; [2]Standardised score

3.3.2 Correlational Analysis

Table 3.2 shows correlations between the family SES composite, the five factors created from the exposure variables, and the composite scores created from the sentence structure familiarity rating tasks. There were no relationships present between the family SES measure and the other variables in the study. Specifically, the SES composite did not correlate with any of the factors of language exposure, nor with any of the measures of offline language processing.

When this was further investigated, a small significant correlation was found between mother's education and expressive grammar (Table 3.3). Additionally, some relationships were found between the individual indicators of SES and language exposure. Father's education was negatively correlated with *Communication and Social Media Use*, and mother's and father's education were negatively correlated with *Reading for Academic Purposes*. Additionally, father's occupation was significantly correlated with *Reading for Academic Purposes*.

With regards to the relationship between the language exposure measures and the measures of offline language processing, only a small negative correlation was

found between vocabulary and factor 2 which represents *communication and social media use* (Table 3.2).

Table 3.2
Correlations between SES, Language Exposure Factors and Offline Measure of Language Use

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10
1. Family SES composite										
2. Factor 1 - *Recreational Reading*	-.01									
3. Factor 2 - *Communication and Social Media Use*	-.03	.00								
4. Factor 3 - *Reading for Academic Purposes*	-.01	.00	.00							
5. Factor 4 - *Information Exposure*	-.07	.00	.00	.00						
6. Factor 5 – *Accessibility to Reading Material*	.01	.00	.00	.00	.00					
7. Receptive grammar	-.01	-.01	.03	-.04	.001	.06				
8. Expressive grammar	.17	-.02	.01	-.03	-.09	.04	**.28****			
9. Vocabulary skill	.02	-.001	**-.19***	-.13	.09	.10	**.18***	**.20****		
10. Non-verbal IQ	.07	-.05	-.02	-.04	-.03	**.23****	**.23****	**.20****	.08	

*Note: *p<.05; **p<.01; SES= Socioeconomic status*

Table 3.3
Correlations between individual predictors of SES, Language Exposure Factors and Offline Measure of Language Use

	1.	2.	3.	4.	5.
1. Mother's education					
2. Father's education	**.38****				
3. Mother's occupation	**.22****	-.01			
4. Father's occupation	.07	**.21****	**.24****		
5. Household Income	**.27****	**.30****	**.17****	**.29****	
6. Factor 1 - *Recreational Reading*	.03	.02	-.13	.04	.05
7. Factor 2 - *Communication and Social Media Use*	-.03	**-.16***	.07	-.01	-.04
8. Factor 3 - *Reading for Academic Purposes*	**-.16***	**-.15***	.06	**.15***	-.06
9. Factor 4 - *Information Exposure*	-.08	-.02	-.05	-.03	-.04
10. Factor 5 – *Accessibility to Reading Material*	-.02	-.03	.01	.03	.01
11. Receptive grammar	-.03	-.13	-.03	-.01	.01
12. Expressive grammar	**.18***	.07	-.02	.10	.13
13. Vocabulary skill	.06	.14	-.05	.13	.06
14. Non-verbal IQ	.05	.05	-.02	.01	.07

*Note: *p<.05; **p<.01*

3.3.3 Exploratory Analysis

3.3.3.1 Correlations with the Sentence Structure Familiarity Rating Tasks

In order to assess the newly developed sentence structure familiarity rating task, intercorrelations were examined between the different sentence familiarity structure items and familiarity tasks (Table 3.4). There was a strong positive correlation between the ratings of subject-first and object-first sentence structures in the individual sentence familiarity task. Ratings of different structures in the comparative sentence familiarity tasks were for the most part significantly positively correlated, with correlations ranging from weak to strong. Mean ORC familiarity was most strongly correlated with mean active familiarity, and mean PRC familiarity with the mean passive familiarity. Interestingly, mean ORC familiarity assessed in the comparative sentence familiarity task was correlated with the mean subject-first familiarity in the individual sentence familiarity task, but not with object-first familiarity.

Correlations were also examined between the sentence structure familiarity tasks and other variables of interest (Table 3.4). Familiarity of ORCs was significantly correlated with the *Communication and Social Media Use* factor, and negatively correlated with the *Information Exposure* factor, which includes newspaper reading. Additionally, a positive relationship was found between mean passive familiarity and the *Accessibility to Reading Material* factor, which had a strong loading of the ART.

Receptive and expressive grammar significantly correlated with mean familiarity of actives and ORCs in the comparative structure rating task (Table 3.4). There were no other significant relationships between sentence familiarity ratings and offline language processing measures.

Table 3.4

Correlations between Sentence Familiarity Rating Tasks, Language Exposure Factors and Offline Measure of Language Use

	1.	2.	3.	4.	5.	6.	7.
1. Mean subject-first familiarity [1]							
2. Mean object-first familiarity [2]	**.69****						
3. Mean Active familiarity [3]	**.21****	.04					
4. Mean Passive familiarity [4]	**.15***	**.20****	**.22****				
5. Mean ORC familiarity [5]	**.16***	.09	**.59****	**.41****			
6. Mean PRC familiarity [6]	**.14***	**.16***	**.30****	**.67****	**.23****		
7. Mean Ditransitive familiarity [7]	**.21***	.12	**.68****	**.67****	**.65****	**.56****	
8. Factor 1 - *Recreational Reading*	-.05	-.12	.01	.08	.04	-.08	.001
9. Factor 2 - *Communication and Social Media Use*	.03	.06	.02	.11	**.19****	.12	.13
10. Factor 3 - *Reading for Academic Purposes*	.02	.04	.08	.05	-.10	.05	-.001
11. Factor 4 - *Information Exposure*	-.03	-.001	-.09	-.02	**-.14***	.09	-.08
12. Factor 5 – *Accessibility to Reading Material*	-.08	.04	-.001	**.15***	.06	.08	.12
13. Receptive grammar	.15	.05	**.20****	-.03	**.20***	-.03	.14
14. Expressive grammar	.08	.02	**.21****	.02	**.16***	-.08	.12
15. Vocabulary skill	.02	-.05	.07	.07	.03	.05	.09
16. Non-verbal IQ	.06	-.01	**.15***	-.04	.10	-.07	.04

*Note: *p<.05; **p<.01; ORC= Object Relative Clause; PRC= Passive Relative Clause; [1] Mean of all subject-first sentences in the individual rating task; [2] Mean of all object-first sentences in the individual rating task; [3] Mean of all active sentences in the comparative rating task; [4] Mean of all passive sentences in the comparative rating task; [5] Mean of all ORCs in the comparative rating task; [6] Mean of all PRCs in the comparative rating task; [7]Mean of all ditransitive sentences in the comparative rating task.*

3.3.3.2 Analysis of Offline Language Use Tasks

While all offline language processing tests used in the current study are standardised for adults, the results show that participants were scoring highly on these tasks. One reason for this could be the materials within each task, particularly for the grammar tasks. For example, within the TROG-2, most sentences follow a simpler word order, with only the final few blocks covering more complex syntactic structures. Due to this, most participants within this study are scoring highly on this test (*M*= 17.77, *SD*= 1.71). Thus, while informative, the results found using each manual's scoring may under-represent the language skills of adults in this study. For that reason, additional

analyses were conducted on the receptive grammar subtest to target more complex language skills.

In a recent study, Kidd, Donnelly, and Christiansen (2017) reviewed individual differences in language acquisition and processing, assessing how differences occur across development. When assessing the TROG-2 items in depth, Kidd et al. (2017) separated out the six most complex structures to study whether comprehension differs depending on the structure of the sentence, and whether comprehension accuracy of structures increases with age. The results indicated that by age 12, all participants scored at ceiling for subject relative clauses, which follow a typical word order in English, whereas only 25% of participants performed at ceiling for centre-embedded clauses by age 15. This shows that there is much more variation in scores for more complex structures from adolescence.

In the following analysis, the same six structures used in Kidd et al. (2017) were analysed separately from the entire test to investigate if this performance variation is seen in the current sample; and if so, whether there is a relationship with other constructs examined in the study, such as language exposure and SES. A composite score was created for this subset of sentences by combining the raw score for each structure. This created a total raw score out of 24, as each structure has a separate block with a total score of four per block. Correlations between this composite score, SES, mean familiarity rating of sentences, and the five exposure factors are shown in Table 3.5.

As can be seen, there is a small negative relationship between the TROG-2 complex structures composite score and SES, suggesting that the higher an individual's score on the six most complex items of receptive grammar, the lower the individual's SES. Additionally, the complex structures composite significantly correlates with

familiarity ratings of subject-first sentence structures in the individual rating task, indicating that the more familiar an individual is with subject-first structures, the higher the individual scores on these more complex structures in a test of receptive grammar.

Table 3.5
Correlations between TROG-2 complex structures composite score and other variables

	1.
1. TROG-2 composite score	
2. Family SES composite	**-.17***
3. Factor 1 - *Recreational reading*	-.05
4. Factor 2 - *Communication and social media*	.06
5. Factor 3 - *Reading for academic purposes*	.06
6. Factor 4 - *Information exposure*	.03
7. Factor 5 - *Accessibility to reading material*	-.02
8. Mean subject-first familiarity [1]	**.19***
9. Mean object-first familiarity [2]	.05
10. Mean Active familiarity [3]	-.00
11. Mean Passive familiarity [4]	.13
12. Mean ORC familiarity [5]	.04
13. Mean PRC familiarity [6]	.07
14. Mean Ditransitive familiarity [7]	.10

*Note: *p<.05; **p<.01; SES= Socioeconomic status; ORC= Object Relative Clause; PRC= Passive Relative Clause; [1] Mean of all subject-first sentences in the individual rating task; [2] Mean of all object-first sentences in the individual rating task; [3] Mean of all active sentences in the comparative rating task; [4] Mean of all passive sentences in the comparative rating task; [5] Mean of all ORCs in the comparative rating task; [6] Mean of all PRCs in the comparative rating task; [7]Mean of all ditransitive sentences in the comparative rating task*

3.4 Discussion

The main aim of the study presented in Chapter 3 was to investigate the relationships between some key variables of interest. The first two questions related to the relationships between SES and exposure to written and spoken language on the one

hand, and offline language processing on the other, in a sample of young adults. The results showed no significant correlations between the family SES composite and the five language exposure factors identified previously, although some small significant relationships were found with the individual indicators of SES. Previous studies have found maternal education to have the strongest relationship with language exposure, compared to other SES measures (e.g. Hoff, 2003; Huttenlocher et al., 2007). For example, Hoff (2003) found that the difference in vocabulary knowledge between HSES and LSES children was explained by differences in mother's speech. While the individual indicators of SES correlated with one another, supporting the use of a composite measure, there was no relationship found with measures of written and spoken language exposure in the current study.

No significant relationships were found between the family SES composite and offline language processing. However, a significant positive relationship was found between maternal education and expressive grammar. Previous research using similar measures of SES in a university sample, along with measures of vocabulary and language processing showed no significant relationships between SES and vocabulary scores, and real-time language processing (Troyer & Borovsky, 2017). However, maternal education alone was associated with real time processing of targets. The authors conclude that maternal education may influence adult language processing more than measures such as occupation or income. The current study adds to this finding as maternal education was the only SES measure to correlate with a measure of offline language processing, which was expressive grammar.

The lack of relationships with SES in the current study could be due to several factors. First, the measures chosen to investigate SES in a university sample might not have been appropriate for this transitory population. Many university students leave the

family home, and therefore, may be less likely to be directly influenced by parental SES, as in childhood. However, they do not yet have a stable income, occupation, or education, as they are continuing further study, and so their own SES cannot be measured. This transitional period makes it difficult to categorise young adults when assessing SES. For this reason, a different measure of SES should be considered in subsequent studies, if possible, which specifically attempts to capture the SES of young adults. Shavers (2007) evaluates the issues regarding these measures of SES and suggests using a multilevel approach, which combines compositional measures, such as income and education, and contextual measures, such as neighbourhood and geographic area.

A second possible reason for a lack of relationships with SES could be that the current sample was not recruited from a wide range of SES backgrounds. However, as illustrated in the figures presented in Appendix 3, there was a good range of participants from low and high SES backgrounds. Finally, a lack of relationship between SES measures and language processing may be due to the cumulative positive effects of education over a long period of time. In the current sample, participants were university students who have completed 13 years of compulsory primary and secondary education. This might have compensated for any early SES-related influences on language development for participants from lower SES backgrounds.

The third main research question in the current study was whether a difference in language exposure relates to offline language processing, measured using standardised tests of vocabulary and grammar in young adults. Written and spoken language exposure was measured using the factors identified in Chapter 2 that captured the following aspects of language exposure: Factor 1 represented *Recreational Reading* as this factor included measures concerning book reading, factor 2 included aspects of

social media, online messaging and texting and therefore represented *Communication and Social Media Use,* factor 3 represented *Reading for Academic Purposes* and included measures of reading academic materials and textbooks, factor 4 included measures of reading newspapers and email and therefore represented *Information Exposure,* and factor 5 represented *Accessibility of Reading Materials* due to the ART and number of books in the family home loading onto this factor.

Only a small negative relationship was found between the *Communication and Social Media Use* factor and vocabulary skill, but no relationships were found with other measures of exposure. Additionally, no relationships were identified between the five factors of exposure and either expressive or receptive grammar. One reason for this lack of relationships could be that the measures of offline language processing may under-represent the language skills of adults in this study as the measures only include a small proportion of trials targeting complex language. Therefore, these measures were explored in more detail.

An exploratory analysis examined the relationship between sentence structure familiarity and receptive grammar. When the most complex structures contained in the TROG-2 test were analysed separately, some significant relationships were observed. A significant correlation was found between the TROG-2 complex structures composite and the mean familiarity of subject-first sentence structures. This relationship suggests that the more familiar an individual is with the simple sentence structures in language, such as subject-first structures, the more accurately they process more complex structures. This relationship seems unusual at first, as subject-first structures are easier to comprehend than object-first structures (Wells et al., 2009), and the TROG-2 composite score is made up of the most complex items in the test. However, this finding could suggest that individuals who have mastered the simpler subject-first structures

may be more equipped to process more complex structures, as presented in the TROG-2 composite score. In other words, the simple sentences in language need to be understood well to be able to help process more complex structures more efficiently.

Additionally, this study aimed to investigate whether written and spoken language exposure relates to familiarity of the syntactic structures examined in the sentence structure familiarity rating tasks. Correlational analyses showed familiarity of ORCs, taken from the comparative rating task, significantly correlated with the spoken interaction factor, *Communication and Social Media Use*, and negatively correlated with the *Information Exposure* factor. Additionally, a small positive relationship between the *Accessibility to Reading Material* factor, with ART strongly loading onto this factor, and familiarity of passive sentences was found. These relationships follow the results of corpus data that show a relatively higher frequency of ORCs in spoken language, and higher frequency of passive structures in written language (Roland et al., 2007). Together, these analyses suggest that the sentence structure familiarity rating task captures some aspects of written and spoken language exposure.

The comparative sentence familiarity rating task, in which participants are asked to rate familiarity of two sentences that have the same meaning but different structures, seems to be more informative than the individual rating task, in which structures are rated individually. The four types of sentences used in the comparative task, that is actives, passives, ORCs and PRCs, have been the focus of previous studies looking at some of these relationships, such as SES and sentence processing (Huang, Leech, & Rowe, 2017). Huang et al. (2017) showed an effect of SES on processing of passive structures in children, but no effect for active structures. Within the current study, SES showed no relationship with passive or active structures.

Results of the current study showed that when correlating the sentences used in the comparative task with other measures used in the study, some significant relationships were seen. Mean familiarity for active structures and ORCs significantly correlated with receptive and expressive grammar tasks. Additionally, mean familiarity of ORCs correlated with several language exposure factors. Yet no significant relationships were found with the individual rating task. Given these results, more focus should be given to the comparative rating task in further studies. More importantly, the correlations between sentence structure familiarity ratings and receptive and expressive grammar suggest that, perhaps less directly, written and spoken language exposure influence offline language processing: increased exposure increases structure familiarity which in turns facilitates offline language processing.

It is evident that measuring an individual's overall exposure to simple and complex sentence structures is difficult. While other studies have manipulated exposure of a small number of specific structures (Wells et al., 2009), there is no study to date that has attempted to measure exposure to different structures that exist in language. Therefore, the findings should be viewed as preliminary for further studies to build upon.

In order to evaluate the findings from this study, methodological limitations must be considered. The ART is a widely used measure of print exposure, which in the majority of studies that have used this test alongside measures of vocabulary knowledge, have found a clear positive relationship between the ART and vocabulary knowledge. However, these relationships were not found in this study. Therefore, this relationship needs to be looked into in the next study.

In conclusion, the results showed that in this sample of young adults, there was no relationship between SES and language exposure, and only weak relationships

between measures of SES and offline language processing. Additionally, language exposure did not strongly relate to offline language processing. The newly developed sentence structure familiarity rating task, as an indirect measure of language exposure, showed some relationships with the standardised tests of receptive and expressive grammar. The next study, presented in Chapter 4, extends these findings by reviewing the measures used for assessing SES, language exposure and language use, and incorporating online measures of language use to further assess the key research questions.

Chapter 4: Relationship between SES, Language Exposure, and Language Use in Young Adults

4.1 Introduction

The results from Study 1 presented in Chapter 3 showed that there was no relationship between SES and language exposure or language processing in the sample of young adults, and only few weak relationships when individual indicators of SES were examined. Additionally, no strong relationships were found between language exposure and offline language use. Indirect relationships were found between language exposure and the standardised tests of receptive and expressive grammar through the correlations with the newly developed sentence structure familiarity rating task. These results could suggest that measuring these variables in a young adult sample is complex. The following study aims to build upon this research by looking at alternative ways to measure SES, language exposure, and language processing, and incorporating online measures of language use.

4.1.1 Socio-economic Status

In Study 1, using measures of parental education, parental occupation, and household income, no strong relationship was found between SES and language exposure in the sample of young adults. Given that the sample was made up of university students, the objective measures assessing parental values may not capture this transitional period of the young adult. Therefore in Study 2, a second measure of SES was included.

The MacArthur Scale of Subjective Social Status (SSS, Adler, Epel, Castellazzo, & Ickovics, 2000) was used as a subjective measure of SES. The SSS asks respondents to rank themselves on a 10-part scale, represented as a ladder. The top of the ladder represents those people who are the best off – those who have the most

money, the most education, and the most respected jobs. At the bottom are the people who are the worst off – those who have the least money, least education, the least respected jobs, or no job. Given this information, respondents are asked to indicate where they think they would position themselves on this ladder, relative to other people in the UK. This measure was adapted to ask participants to rank themselves at three different time points: (1) at this point in time, (2) where themselves and their family stood in the respondents' early childhood (0-5 years of age), and (3) where themselves and their family stood in the respondents' later childhood (5-18 years of age). This was assessed at three different ages to cover different periods of the individuals' life where SES may influence language in different ways. The early childhood period covers the age at which individuals begin to learn language, later childhood covers the period of the onset of literacy and through primary and secondary education. Therefore, as children begin reading and continue through education, they will be exposed to increasingly more complex language that is available in written texts (Montag & MacDonald, 2015; Roland, Dick, & Elman, 2007). Finally, assessing the participants' SSS at this point in time helps to investigate how SES may influence language exposure and language processing beyond childhood.

4.1.2 Language Exposure

The results of Study 1 showed a lack of strong relationships between language exposure and offline language processing, measured using standardised tests of vocabulary and grammar. The language exposure measures that were included in Study 1 have been reliably used in previous research (e.g. Acheson, Wells, & MacDonald, 2008; James, Fraundorf, Lee, & Watson, 2018; Stanovich & West, 1989), and so it is

unlikely that the lack of relationships is due to these measures. Therefore these measures remained for Study 2 with some adaptations.

The questionnaire assessing language exposure in Study 2 included sections on Reading Habits and Comparative Reading Habits (CRH) and all items in these sections remained the same as in Study 1. The Reading Time section also remained, however, items tapping time spent reading graphic novels and magazines were removed due to a highly positively skew found in Study 1. The Author Recognition Test (ART) was again used as a measure of written language exposure and remained the same.

As the comparative sentence familiarity rating task was an informative measure of exposure to a range of sentence structures in Study 1, this task remained in the questionnaire. However, the individual rating task was less informative and therefore, not included in the revised questionnaire.

In Study 1, most of the spoken language exposure items did not load onto a single factor in the factor analysis, and the test-retest reliability of this measure was poor. The spoken language exposure questions were modelled on the Reading Time measure of print exposure, and participants were asked to report number of hours per day spent in different spoken contexts, such as talking with friends and family, watching TV and texting. It is possible that participants struggled to accurately report their spoken language exposure this way. Therefore, this section of the questionnaire was revised. A newly developed comparative measure was used to assess spoken language exposure in Study 2. As in the CRH section assessing written language exposure, the comparative spoken language measure asked participants to report time spent in a range of spoken language contexts compared to their peers. This change may result in a more reliable measure of spoken language exposure in this sample, as it was found for CRH (e.g., Acheson et al. 2008).

4.1.3 Language Use

In Study 1, using standardised measures of vocabulary and grammar that focus on offline processing, the results showed little relationship between the measures of written and spoken language exposure and language processing. This relationship will again be examined in Study 2, using different measures of offline processing, and with the addition of online measures of language use. The measures of language included measures of vocabulary, sentence comprehension and production, paragraph comprehension, and a measure of reading fluency.

This section is structured as follows: First, a systematised review of studies examining the relationship between measures of vocabulary and print exposure in adults is presented. This review provides a rationale for the choice of two vocabulary measures used in Study 2, one assessing vocabulary depth and one vocabulary breadth. Second, a sentence comprehension measure is described based on studies of online sentence comprehension. Third, a set of sentence production measures is introduced, one measuring online language production, and one using a standardised sentence production task. Finally, the measures of paragraph comprehension and reading fluency are described.

4.1.3.1 Vocabulary Measures

An unexpected finding in Study 1 was a lack of relationship between vocabulary knowledge and print exposure in the young adult sample. There is strong evidence of the relationship between vocabulary and written language exposure in previous research (e.g. Acheson et al., 2008; Stanovich & West, 1989). As has been mentioned previously, the print exposure measures that were included in the questionnaire have been reliably used many times in previous research (e.g. Acheson et al., 2008; James et

al., 2018; Stanovich & West, 1989). Therefore, the vocabulary test used in Study 1 should be questioned for its ability to capture vocabulary knowledge in this sample. Consequently, a systematised review was conducted to examine studies that have used one or more vocabulary measures along with measures of language exposure in a young adult sample and assess the types of relationships found.

An individual's vocabulary is the knowledge that the individual possesses about the words in a language. As defined by Stahl (2005), "Vocabulary knowledge is knowledge; the knowledge of a word not only implies a definition, but also implies how that word fits into the world".

Vocabulary acquisition first begins by learning oral vocabulary, through hearing spoken language as a child. Following this, when learning to read begins, new vocabulary can be learned through both written and spoken language, as well as other important aspects of language learning, including orthography, phonology, and semantics (Ricketts, Bishop, & Nation, 2009). After childhood, new vocabulary is acquired during the lifespan, but at a much slower pace (Diamond & Gutlohn, 2006; Ricketts et al., 2009).

There is a consensus that vocabulary knowledge is crucial for language comprehension, with the relationship between the two becoming stronger as children get older (Milton & Treffers-Daller, 2013; Nation, 2009; Tannenbaum, Torgesen, & Wagner, 2006; Wilson et al., 2016). According to Nation (2009), there are two main components of reading comprehension: decoding of individual words and understanding the meaning of the passage. Research has investigated to what extent vocabulary is important for both decoding and understanding. When testing school-aged children, Ricketts, Bishop, and Nation (2009) found that vocabulary was important for both aspects of reading comprehension. Results showed that vocabulary

significantly correlated with decoding (r = .34) and text reading (r = .63). Additionally, vocabulary alone accounted for 17.8% of variance in a regression model predicting reading comprehension.

As vocabulary knowledge underpins language, it is important to be able to reliably measure this in both children and adults. Vocabulary is often measured in two distinct ways, with studies either measuring number of words in the mental lexicon (vocabulary size) or how well words are understood (vocabulary knowledge, Schmitt, 2014). Vocabulary size, or breadth, is the number of words known at a surface level, such as recognising a string of letters as a word but perhaps not knowing the meaning (Qian & Schedl, 2004). It is usually measured using a yes/no framework for each item, and therefore, many items can be administered in a short period of time. On the other hand, vocabulary knowledge, or depth, measures how well a word is understood in detail, such as its meaning, pronunciation, and other lexical properties (Qian & Schedl, 2004). Vocabulary depth is usually measured using fewer items, where tests ask individuals to provide a definition of each item (Laufer & Goldstein, 2004).

Many studies only use one measure when assessing vocabulary, however, this can be problematic when measuring vocabulary reliably. Vocabulary size tests are considered as superficial for not assessing an individual's knowledge of all aspects of language, whereas tests of vocabulary depth are criticised for only assessing a limited number of items and therefore cannot be a true reflection of overall knowledge (Laufer & Goldstein, 2004). Nation (2009) suggests that vocabulary knowledge needs to be flexible and efficient in order to understand aspects of the word, such as knowing one or more meanings of the word, pronunciation, and also the ability to apply the correct meaning depending on the context in which the word is used. However, only measuring

how many words an individual knows is much too simple to fully understand an individual's vocabulary knowledge.

Previous studies aiming to measure either vocabulary size or vocabulary knowledge have used several different test formats, including assessing word synonyms, word antonyms, lexical decision, producing word definitions, and multiple-choice vocabulary tasks. Bowles & Salthouse (2008) assessed whether different formats of vocabulary tests are more suitable depending on age and cognitive ability. Bowles and Salthouse (2008) analysed data from 18 previously published studies where at least two vocabulary tasks were administered to adults, in addition to examining a range of other cognitive abilities. The results showed that age was positively related to scores on vocabulary tests, even when age was considered as non-linear (Bowles & Salthouse, 2008). A main finding showed that following childhood, vocabulary scores indicate an age-related increase, before peaking, and then slowly declining when entering old age. The same trend was found for all vocabulary tests reviewed, however the strength of these results differed depending on the type of test. A correlation of r=.30 was found between age and a vocabulary picture identification task, whereas the smallest correlation of r=.14 was found between age and a vocabulary definitions task. This finding demonstrates that the type of test used can influence the results found, depending on age.

This systematised review examines studies which have used one or more vocabulary measures, along with measures of language exposure. The majority of existing UK standardised tests to measure vocabulary knowledge are aimed at testing children, and fewer tests to measure vocabulary in adults are available. As shown by Bowles and Salthouse (2008), the type of test matters when measuring vocabulary in adults. Therefore, this review aims to examine the tests available to

measure vocabulary knowledge in adults and look at the types of results found with other variables important for the current study.

Four online databases (ERIC, PsycARTICLES, PsycINFO, Scopus) were searched between January and April 2019 to identify studies for possible inclusion. Search terms included *vocabulary*, *vocabulary knowledge, vocabulary skill, language, exposure*, *print exposure, adults.* Searches were limited to English-language, peer-reviewed studies of adult populations. No date restriction was placed on the search. A total of 581 articles were retrieved. To be included in the review, the following criteria were considered: the number of participants in the sample was specified; the study measured vocabulary using at least one test of vocabulary knowledge; the methodology and results were explicitly described; relationships were explored between vocabulary and other measures in the study.

In the first instance, titles and abstracts were reviewed to remove duplicates and studies that did not include a sample of adults or native English speakers. The remaining articles (n = 427) were examined in detail and a total of 19 studies were identified and included in the review based on the inclusion criteria (Figure 4.1). All studies were cross-sectional in design. Reference lists of included studies were also scanned to identify other potential studies that may not have been extracted from the online databases; however, no additional studies were found.

From each included study, the country in which the study was conducted, sample size, vocabulary measures used, and key findings were identified. Primary outcomes investigated were strength of relationships between vocabulary measures and print exposure.

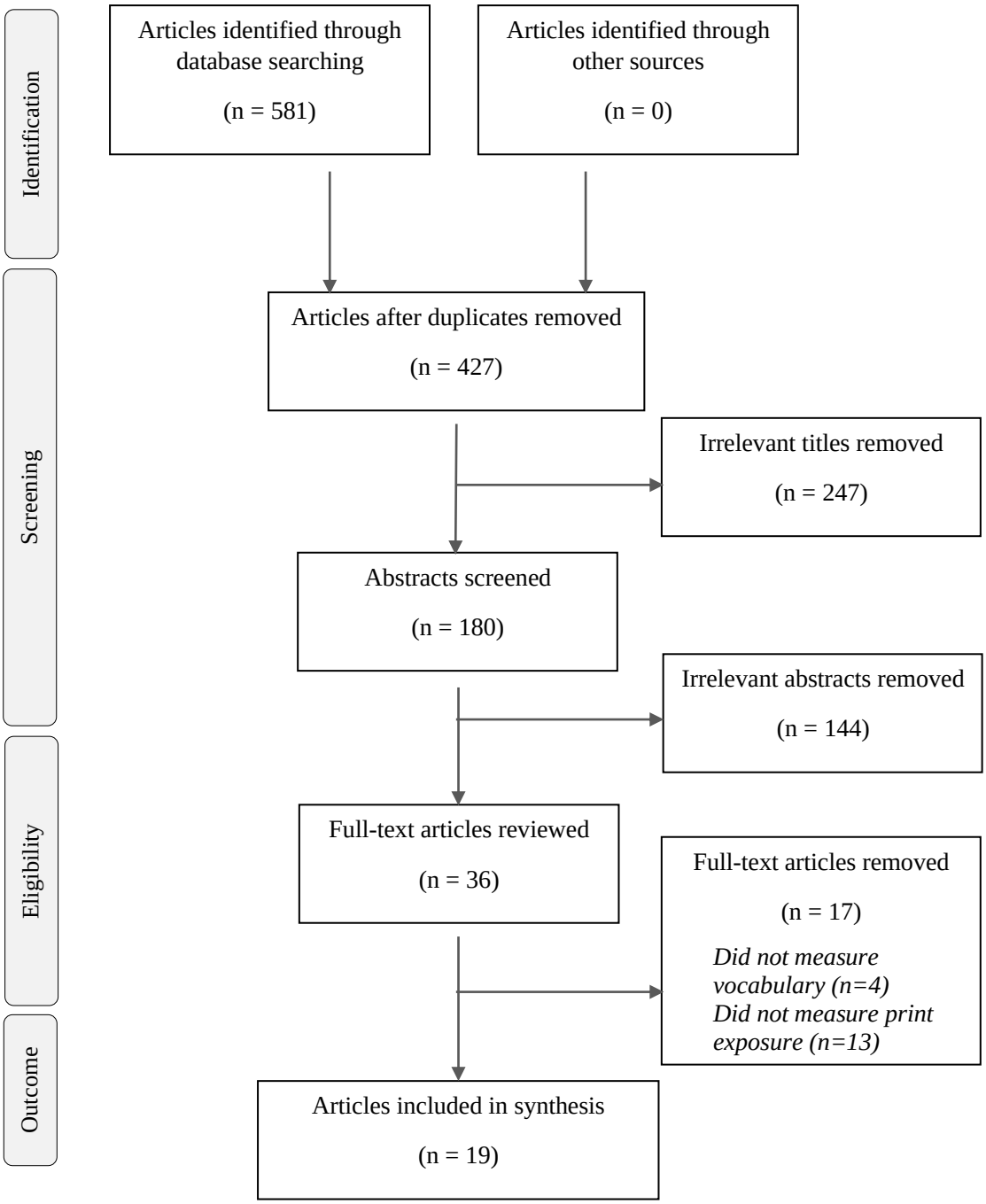

Figure 4.1
PRISMA flow diagram of article search and selection process (Moher, Liberati, Tetzlaff, & Altman, 2009)

Overall there were 10 tests, including various editions, used to measure vocabulary across 19 studies (Table 4.1). The two most popular tests used, which were included in multiple studies, were the Peabody Picture Vocabulary Test (PPVT) and the Nelson-Denny Vocabulary Test. The studies also used several ways of measuring

vocabulary, including assessing knowledge of synonyms and antonyms, defining words orally or through a multiple-choice format, and receptive vocabulary picture tasks.

Table 4.1
Summary of Vocabulary Measures Used in Reviewed Studies, Organised by Number of Occurrences Per Measure

Vocabulary measure	Edition	Number of occurrences in the reviewed studies	Countries in which the test is standardised
Peabody Picture Vocabulary Test (Dunn & Dunn, 2007)	1st 3rd 4th Revised	1 3 1 2	USA
Nelson-Denny Vocabulary Test (Brown, 1960)	1st	6	USA
Shipley Institute of Living Scale: Vocabulary subtest (Shipley, 1940)	1st	3	USA
Weschler Abbreviated Scale of Intelligence: Vocabulary Subtest (Wechsler, 2011)	1st	2	USA UK
Ekstrom Battery: Extended range vocabulary and Advanced vocabulary subtests (Ekstrom, French, Harman, & Dermen, 1976)	1st	2	Not Standardised
Vocabulary Size Test (Nation & Beglar, 2007)	1st	2	Not Standardised
Checklist and foils test of vocabulary (Freebody & Anderson, 1983)	1st	1	Not Standardised
Goulden Vocabulary Size Test (Goulden, Nation, & Read, 1990)	1st	1	Not Standardised
Synonym task (Mar & Rain, 2015)	1st	1	Not Standardised
Weschler Abbreviated Intelligence Scale – Revised (WAIS-R) – Vocabulary Subtest (Wechsler, D., 1981)	1st	1	USA UK

Overall, vocabulary significantly correlated with measures of print exposure, including medium to high correlations with the ART, in all but one study (Misyak &

Christiansen, 2012), which is a highly used, reliable measure of exposure to fiction books (Stanovich & West, 1989). The most commonly used tests were standardised in the USA, but at the time of the review, do not have a version that is standardised in the UK. The Peabody Picture Vocabulary Test was moderately to highly correlated with language exposure measures in the studies reviewed, including the ART (*r*=.53-.68) and MRT (*r*=.41-.69). The Nelson-Denny Reading Test vocabulary subtest was moderately correlated with language exposure measures, such as the ART (*r*=.32-.58). The Weschler Abbreviated Scale of Intelligence: Vocabulary Subtest (WASI, Psychological Corporation, 1999), which the second edition was used in Study 1, was used only in two studies, and strong relationships were found in both with the ART and Magazine Recognition Test (MRT, Cunningham & Stanovich, 1990). A full table of findings for the systematised review is presented in Appendix 32.Based on the results of the systematised review, two measures of vocabulary were included in Study 2. One test assessed vocabulary depth using the synonyms task from the Nelson-Denny Reading Test (Brown, 1960). The Nelson-Denny Reading Test was one of the most common tests used in the studies reviewed and showed consistent significant relationships with measures of print exposure. Vocabulary breadth was measured using the LexTALE lexical decision task (Lemhöfer & Broersma, 2012). The LexTALE task was not one of the tests found in the systematic review, but… Using these measures allowed both vocabulary depth and breadth to be measured which is important to try and fully examine an individual's vocabulary knowledge. Using more than one measure of vocabulary also allowed different aspects of vocabulary knowledge to be examined in relation to SES and language exposure.

4.1.3.2 Sentence Comprehension Measures

In order to measure sentence comprehension, the online sentence comprehension task used in Wells et al. (2009) was included in this study. Wells et al. (2009) manipulated participants' experience with subject relative clauses (SRC) and object relative clauses (ORC) to assess how this experience affects comprehension of these complex structures. The difference between SRCs and ORCs lies in the position of the noun, and whether it is the subject, or the object of the action being produced (Wells et al., 2009), as in (3a) and (3b). ORCs are typically found to be more difficult to comprehend than SRCs, in terms of comprehension accuracy and reading times. ORCs have been found to be less common in written language compared to SRCs (Roland et al., 2007). Therefore, Wells et al. (2009) argued that more experience is needed with this structure in order to comprehend it accurately.

(3a) Subject relative: *The clerk that trained the typist told the truth.*
(3b) Object relative: *The clerk that the typist trained told the truth.*

In the Wells et al. (2009) study, participants were split into an experience group and a control group. The experience group received experience with both SRCs and ORCs, while the control group received no experience with either type of relative clause. Comprehension of SRCs and ORCs was tested in both groups pre- and post-experience manipulation. In the pre- and post-test, a self-paced reading task measured reading time of each word in the sentence, as well as accuracy of answering a comprehension question following the sentence. The authors hypothesised that the increased experience with ORCs would increase comprehension accuracy and reduce reading time at the main verb. The main verb (*told* in examples (3a) and (3b) above) is a key aspect of the sentence as it immediately follows the relative clause. This region

has a significantly longer reading time in ORCs as it is the point at which readers may have to go back and reanalyse the relative clause if they have assigned the nouns incorrectly by assuming the sentence would follow a simpler SRC structure. The results of Wells et al. (2009) showed that reading time at the main verb decreased for ORCs making it similar to the reading time for SRCs in the experience group in the post-test, but there was little change in the control group. This suggests that participants benefitted from their experience with ORCs. Wells et al. (2009) argued that the additional experience with the SRCs in the experience group did not benefit their comprehension as they are already high in frequency in the English language. Thus the additional exposure only benefitted the less frequent ORCs.

Other studies have also showed this relationship between experience and online sentence comprehension. For example, James, Fraundorf, Lee and Watson (2018) tested adults using a self-paced moving window task to measure processing of relative clauses. Participants were also tested on a range of cognitive tests assessing phonological ability, language experience, verbal working memory and non-verbal IQ. The results showed that individual differences in language experience and verbal working memory related only to offline comprehension of sentences, measured by accuracy of the comprehension question following the sentence, but not online comprehension measured by reading times.

The current study used the Wells et al. (2009) self-paced reading task to measure online sentence comprehension in a young adult sample.

4.1.3.3 Sentence Production Measures

In order to measure sentence production, two measures were used. First, the picture-description production task from Montag and MacDonald (2014; 2015) was

used to assess online language production. Montag and MacDonald (2015) measured written language exposure and sentence production, focusing on relative clause production, in adults and children. In their study, child and adult participants were assessed on the ability to produce relative clauses, along with measuring text exposure using the ART for adults and Title Recognition Test (TRT, Cunningham & Stanovich, 1990) for children. The results showed that amount of text exposure affected production choices: younger individuals, with less text exposure compared to speech input, produced utterances similar to those found in the speech, whereas adults were shown to produce structures that are most frequently found in text. Specifically, individuals with more text exposure produced more passive relative clauses (PRCs), which were found to be more prevalent in written than spoken language (Montag & MacDonald, 2015). The results also showed that PRCs, specifically be-passives such as *the ball that is being thrown by the man*, were produced more for animate targets than inanimate targets. This task was used in the present study as a measure of online sentence production in a young adult sample.

The second test assessing sentence production was the recalling sentences subtest from the Clinical Evaluations of Language Fundamentals – fifth edition (CELF-5, Wiig, Semel, & Secord, 2013). Although this test is often used as a measure of phonological processing or working memory, previous research has shown that it is also a measure of sentence production (Klem et al., 2015; Nag, Snowling, & Mirković, 2018).

4.1.3.4 Other Language Measures

An additional measure was used to examine passage comprehension, taken from the Nelson-Denny Reading Test (Brown, 1960). The passage comprehension test also

allows for reading fluency to be measured. Reading fluency was used as a control variable when investigating the relationships with sentence and passage comprehension.

4.1.4 Control Measures

In addition to the SES, language exposure, and language use measures, two control measures were included: working memory and non-verbal IQ. As in Study 1, the Wechsler Abbreviated Scale of Intelligence – Second edition (WASI-II, Wechsler, 2011) matrix reasoning subtest was used to measure non-verbal IQ. In addition to this, working memory was measured using the digit span task from the Wechsler Adult Intelligence Scale – Fourth UK Edition (WAIS-IV, Wechsler, 2008). The reason for including a test of working memory and non-verbal IQ was to take into account the contributions of the cognitive processes to the language use tasks. Some theories have proposed that complex sentence structures, such as ORCs, are more difficult to process than SRCs due to the increased memory demands needed to comprehend them (e.g. Just & Carpenter, 1992; Waters & Caplan, 1996). Therefore, these measures were used as control measures when assessing the contribution of language exposure to language use.

4.1.5 Current study

The measures outlined above were used to assess the relationship between the constructs of SES, written and spoken language exposure, and language use in a sample of young adults. Three sets of relationships will be examined: (1) the relationship between SES and language exposure, (2) the relationship between SES and language use, and (3) the relationship between language exposure and language use. If these

relationships are found to be significant, a mediation analysis will be performed to assess whether language exposure mediates the relationship between SES and language processing in young adults.

4.2 Method

4.2.1 Participants

One-hundred and fifty-one participants (35 Males, 116 females) aged 18 to 28 years (M = 20.96, SD = 2.18), took part in this study. Participants were recruited through opportunity sampling and received payment or course credit for their participation. The study was conducted in a single session in a laboratory setting. The study protocol was approved by the Ethics Committee at York St John University.

One-hundred and thirty-eight participants reported no learning difficulties. Six participants reported additional difficulties, including dyslexia and autism. One-hundred and fifty participants reported speaking English as their first language, with 31 reporting being moderately fluent or completely fluent in one or more additional language. For the purposes of the current analyses, one participant was excluded based on being non-native speakers of English, and a further three were excluded due to reporting reading or language difficulties (2 reporting dyslexia, 1 reporting slow language processing and spelling). Therefore, analyses were conducted on data for the remaining 147 participants (33 Males, 114 Females).

4.2.2 Measures

4.2.2.1 Questionnaire: SES and Language Exposure Measures

Adapted versions of the SES and language exposure measures used in Study 1 were administered. Considering the results found in Study 1, the following revisions were made.

Socio-economic status: Familial SES was measured again using indicators of parental occupation (Elias & Birch, 2010), parental education, and household income, as measures of objective SES. The questions and answer options for this section are presented in Appendix 1.

In addition to this, a subjective measure of SES was included, adapted from the MacArthur Scale of Subjective Social Status (SSS, Adler et al., 2000). The SSS asks respondents to rank themselves on three 10-part scales, represented as ladders. Respondents are given the following instructions: "*Think of this ladder as representing where people stand in the UK. At the top of the ladder are the people who are the best off – those who have the most money, the most education, and the most respected jobs. At the bottom are the people who are the worst off – those who have the least money, least education, the least respected jobs, or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom.*" Respondents are asked to indicate where they think they would position themselves on this ladder, relative to other people in the UK, at three different time points: (1) at this point in time, (2) where themselves and their family stood in the respondents' early childhood (0-5 years of age), and (3) where themselves and their family stood in the respondents' later childhood (5-18 years of age). A copy of the subjective SES section can be found in Appendix 2.

Written language exposure: Four measures were used to assess written language exposure. The Reading Habits measure was the same as in Study 1. It asked how many books individuals read in a year, not including academic materials, with answer options ranging from *none* to *40+*, how often individuals visit bookstores and online bookstores, with answer options ranging from *never* to *once or more a week*, and how many books there are in the family home, with answer options ranging from *none* to *200+*.

The second written language exposure section measured Reading Time. Eleven questions were presented which covered textbooks, academic material other than textbooks, fiction books, non-fiction/special interest books, newspapers, e-mail, reading content on social media, and internet media. Answer options ranged from *0* to *7+ hours per week.*

Third, as in Study 1, the Comparative Reading Habits (CRH) section, adapted from Acheson et al. (2008), was included which asked how much time individuals spend reading academic material, fiction, and newspapers and magazines (in print and online), complexity of non-academic material, enjoyment of reading, and time spent on social media, compared to other people their own age. This measure included five answer options ranging from *much less than others* to *much more than others*.

An adapted version of the ART was used, as in Study 1. This included 40 authors and 30 foils. Twenty authors were categorised as literary authors, such as Ernest Hemingway, George Orwell and Margaret Atwood, and 20 were categorised as popular authors, such as Stephen King, James Patterson, and Martina Cole. All the authors were writers of fiction books. Participants are required to select the names that they recognise to be authors. Each correct author selected was scored one point, with a maximum score

of 40 for the ART. One point was deducted for each foil selected. A copy of the written language exposure measures can be found in Appendices 5 to 8.

A newly developed spoken language exposure measure was created which asked participants to indicate how much time they spend communicating and listening to spoken language compared to other people their own age. These two sections were set out in the same format as the CRH section, with answer options ranging from *much less than others* to *much more than others*. The communicative language section included contexts such as talking with friends and family (face to face/over the phone/video chat), instant messaging, phone communication without the need for an internet connection (such as texting) and talking to other players whilst playing online games. The listening to spoken language section included contexts such as watching tv shows/films, watching online video clips, and listening to music, podcasts, and audiobooks. Two additional questions asked how much time the respondent typically spends verbally interacting with other people and listening to spoken language other than their own verbal communication. Answer options for the final two questions ranged from *0* to *7+ hours per day.* The two spoken language exposure sections can be found in Appendix 16.

The comparative sentence structure familiarity rating task was also included, as an indirect measure of language exposure as used in Study 1. This task included pairs of sentences that have a different structure while keeping the meaning the same. For example, the sentence containing an ORC *the pasta that the chef cooked was very tasty* has the same meaning as the sentence containing a PRC *the pasta that was cooked by the chef was very tasty*. The pairs of structures included active and passives, object and passive relative clauses, and ditransitive sentences. The structures used in this task included 13 active/passive pairs, 15 PRC/ORC pairs, and eight ditransitive pairs. Eight

ungrammatical sentences were also included along with the grammatical counterpart. Participants were required to read both sentences in each question and rate how often they encounter each sentence structure on a seven-point rating scale, with 1 indicating that they encounter the sentence *very rarely*, 4 indicating *sometimes*, and seven indicating *very often*. The instructions and items used for this task can be found in Appendices 13 and 15.

4.2.3.2 Language Use Measures: Vocabulary

Vocabulary depth: Vocabulary depth was assessed using the vocabulary subtest from the Nelson Denny Reading Test (Brown, 1960). The Form H version of this task was used. This test includes 80 items, in which a target word is presented in a sentence, for example *to be elastic is to be*, along with five answer options: *A: rigid, B: rigorous, C: elated, D: expandable, E: exacting*. The answer options are synonyms of the target word, and participants are required to select the correct synonym in a multiple-choice format. Each correct answer is scored one point and the highest possible score for this subtest is 80. Percent correct scores were used in analyses for this task. This task took approximately 15 minutes to complete. A copy of the Nelson Denny vocabulary subtest can be found in Appendix 18.

Vocabulary breadth: To measure vocabulary breadth, the Lexical Test for Advanced Learners of English (LexTALE, Lemhöfer & Broersma, 2012) lexical decision task was used. This test consists of 60 items: 40 test items and 20 filler items. The test items include 15 nouns, 12 adjectives, one verb, two verb particles, two adverbs, and eight words that can present as both a noun and a verb. All non-words are orthographically legal and pronounceable in English.

This task was completed on a computer. In each trial, participants were required to press the M key on the keyboard (which was marked green) if they perceived the

string as being a real word, or the Z key (which was marked red) if they thought the string was not a real word. As per the instructions set out by Lemhofer & Broersma (2012) concerning administering the test, all items were presented sequentially, so that all participants saw the words in the same order. Each word was presented one at a time, in the centre of the screen. After participants made a judgement whether the string of letters was a real word or a non-word by pressing a key on the keyboard, the next item immediately followed. The LexTALE task was administered on E-Prime 3.0 experiment presentation software and took approximately 5 minutes to complete. Scoring for this test used a corrected percentage score which takes into account the unequal proportion of words and nonwords. A list of the items used can be found in Appendix 19.

4.2.3.3 Language Use Measure: Sentence Comprehension

A self-paced reading task, taken from Wells et al. (2009), was used to assess online language comprehension. Two lists of sentences were created from the pre- and post-test items used in the Wells et al. (2009) study. These items included 40 subject and object relative clause pairs, and 80 filler items. In each relative clause sentence, the first six words contained the head noun phrase and relative clause, followed by the main verb, and four or more additional words to generate a plausible sentence. Both nouns in the head noun phrase were always animate (*clerk* and *typist* in the examples below), and each relative clause included the relative pronoun 'that'. An example relative clause pair would be:

(SRC) *The clerk that trained the typist told the truth about the missing files*

(ORC) *The clerk that the typist trained told the truth about the missing files*

The filler sentences were similar in length and complexity to the relative clauses and included either multiple prepositions, such as *The bush by the cemetery tower with steep stairs was pruned by the groundskeeper*, or sentential complements, such as *The cooks gossiped that the manager flirted with everyone to amuse herself while working at the diner*.

The 40 relative clause pairs were split between two lists so both lists included 20 SRCs and 20 ORCs, with one of each of the 40 pairs per list. The 80 filler items were the same in both lists. As each list contained 40 test items and 80 fillers, this allowed the same proportion of test and filler items as in the pre- and post-tests conducted in Wells et al. (2009). Assignment of the two lists was counterbalanced by participant so that each participant was only exposed to one list of sentences. Each participant saw 10 practice trials at the beginning of the experiment. Sentences were presented in a random order for each participant. Several words in the sentences were replaced to British English rather than American English, which was the language used in the original study. A full list of sentences and how they were adapted can be found in Appendix 24.

This task was completed on a computer. At the start of each trial, participants saw a series of dashes. Each dash corresponded to a letter or character in the sentence. The participant pressed the spacebar to reveal the first word in the sentence. Each spacebar press after this revealed the next word in the sentence and caused the previous word to return to dashes. After all the words had been viewed, a further spacebar press caused the dashes to disappear. Participants then saw a question on the screen relating to either the main clause or the embedded relative clause of the sentence just read. Participants were then required to press one of two buttons on the keyboard to answer ‘yes’ or ‘no’ to the question. An equal number of questions had a correct answer of

'yes' as those that had a correct answer of 'no'. Feedback was then given on screen as to whether the question was answered correctly. A final spacebar press revealed the next set of dashes in the following trial. A break was offered halfway through the experiment. The data recorded from this task was reading time for each word and question accuracy for the test items. The maximum score for question accuracy was 40, which was converted to percent correct score for the analyses of this task. The comprehension task was administered on E-Prime 3.0 experiment presentation software and took approximately 25 minutes to complete. A list of the experimental and filler sentences used in this task is presented in Appendices 21 and 22. An example of the comprehension subtest procedure can be found in Appendix 23.

4.2.3.4 Language Use Measures: Sentence Production

The relative clause production task, taken from Montag & MacDonald (2014; 2015), was used to assess online language production. This test consisted of 20 test trials and 44 filler trials. Each trial contained a coloured picture (as in Figure 4.2), presented in the centre of the screen, that shows an action taking place by one or more agents. The test trials consisted of pictures representing verbs that can take an animate and inanimate grammatical object. These pictures have multiple scenarios taking place that represent each verb: once acting upon an animate object, and once acting upon an inanimate object. For example, as shown in Figure 4.2, the picture for the verb 'kick' showed a boy kicking a ball and a boy kicking a girl.

Figure 4.2
Example test item for the online sentence production task

After each picture appeared on screen, a spoken question was presented via headphones that asked about an aspect of the picture. For test trials, each question was asked in a way that the participant was required to differentiate between several agents or objects in the picture to fully answer the question. The purpose of this was to elicit an answer that contained a relative clause. For example, for the picture above (Figure 4.2), the question ‘What is orange?’ was designed to query the inanimate theme (the ball), and ‘Who is wearing blue?’ the animate theme (the girl). There were an equal number of questions that examined the animate and inanimate targets, which was counterbalanced across participants. For filler trials the questions only asked what an agent or object in the picture was doing. The picture remained on screen while the participant answered the question. Once the participant had finished answering the question, they were required to press the space bar to continue to the next trial. All responses were audio recorded and transcribed offline.

For the purposes of this study, the questions were recorded by a native British speaker, which replaced the original recordings. Several words in the questions were replaced to British English rather than American English, that was used in the original study. A full list of questions can be found in Appendix 26. Participants were required to verbally answer the question into a microphone and all answers for the test trials were recorded for coding. All recorded sentences were marked as being accurate or inaccurate, and coded for the type of sentence that was produced (object relative clause, passive relative clause, or other). Relative clauses were also coded as to whether a by-phrase or relative pronoun was used, and passive relative clauses were further coded as get-passive or be-passive. The production task was administered on E-Prime 3.0 experiment presentation software and took approximately 20 minutes to complete.

The recalling sentences subtest from the Clinical Evaluations of Language Fundamentals – fifth edition (CELF-5, Wiig, Semel, & Secord, 2013) was included in this study as a second measure of sentence production. This subtest includes two trials and 26 test items, however, for this age group, testing began at item 16. Participants were required to listen to a sentence and repeat the sentence verbatim. The sentences increased in complexity of meaning and structure. Each sentence that is repeated verbatim is scored three points, two points if the participant makes one error, one point if two or three errors are made, and zero points for four or more errors. If the participant correctly recalls the first two items administered (items 16 and 17), all preceding items are scored as three points. However, if the participant does not correctly recall the first two items, the reversal rule is applied, and testing begins at item 1. Scoring is discontinued if the participant makes four or more errors in each sentence on four consecutive sentences. The maximum score for this subtest is 78. Scaled scores were

used for subsequent analyses. This task took approximately 5 minutes to complete. The recalling sentences subtest can be found in Appendix 20.

4.2.3.5 Other Language Use Measures

Passage comprehension: To assess passage comprehension, the comprehension subtest from the Nelson-Denny reading test (Brown, 1960) was utilised. The Form H version of the test was used which requires participants to read seven short passages and answer between five and eight factual and inferential questions relating to the passage. The highest possible score for this subtest is 38. Percent correct scores were used in analyses for this task.

Reading Fluency: The Nelson-Denny comprehension test also allows for reading rate to be measured while participants are reading the first passage of the comprehension subtest. Participants are timed for the first one minute of reading the passage, and then required to indicate what line of the passage they reached in this time. The number of words that has been read up to this line is recorded as reading rate. This task took approximately 20 minutes to complete. An example of the comprehension subtest can be found in Appendix 27.

4.2.3.6 Control measures

Working memory: The working memory subtest from the Wechsler Adult Intelligence Scale – Fourth UK Edition (WAIS-IV, Wechsler, 2008) was included in this study. The working memory subtest involves a forward digit span task, backward digit span task, and a sequential digit span task. For each trial in the three tasks, participants listened to a string of numbers and were required to repeat the numbers in

the same order, a backwards order, or rearrange the numbers into ascending order. There are two practice trials in the backwards and sequential digit span tasks. All three tasks consist of 8 test trials, which become more complex after each trial by increasing the quantity of numbers in the string. Each trial includes two strings of numbers to be repeated and every correct sequence is scored one point. For each task, scoring is discontinued after incorrectly repeating both strings of numbers in the same trial. The maximum score for each task is 16, and for the entire subtest is 48. Scaled scores were used in the subsequent analyses. The working memory task took approximately 5 minutes to complete. The working memory subtest can be found in Appendix 31.

Non-verbal IQ: The matrix reasoning subtest from the Wechsler Abbreviated Scale of Intelligence - Second Edition (WASI-II, Wechsler, 2011) was also included in this study as a measure of non-verbal IQ. The matrix reasoning subtest involves showing an incomplete matrix or series and asking participants to choose one picture from a selection of five pictures that completes the presented pattern. Each correct answer is scored one point, and the maximum score for this subtest is 30. Scoring is discontinued after three consecutive incorrect responses (Wechsler, 2011). Scaled scores were used for analyses. An example of the WASI-II subtest can be found in Appendix 30.

4.2.4 Procedure

Each participant completed the study in a single testing session, which took approximately two hours. Participants were seated at a computer and asked to complete a consent form and answer the demographic questions (e.g. gender, date of birth, native language). A questionnaire was completed first, which included the measures of SES, written and spoken language exposure, and the Sentence Structure Familiarity Rating

task, and was implemented on the Qualtrics online survey platform. The questionnaire was followed by the online sentence production task and three of the standardised tests: recalling sentences, digit span and the vocabulary depth task. Participants were then offered a break lasting approximately five minutes. After the break, participants were again seated at the computer to complete the online sentence comprehension task, followed by the matrix reasoning subtest, vocabulary breadth task, and the passage comprehension test. The order of the tasks was the same for each participant in order to minimize experiment variability.

4.3 Results

The results section is structured as follows. The first three sections will examine the measures used for the three key constructs: SES, language exposure and language use. These sections will involve correlational analyses between different measures for each of the constructs, and factor analyses for the measures of SES and language exposure. Following this, key relationships between the constructs will be explored to address the main research questions. Specifically, multiple regression analyses will be used to examine (1) the relationship between SES and language exposure, (2) the relationship between SES and language use, and (3) the relationship between language exposure and language use.

4.3.1 Analyses of Socio-economic Status Measures

4.3.1.1 Descriptive Statistics of SES Measures

Participants in this sample were from a broad range of SES groups, as shown in Table 4.2 and Appendix 4. As can be seen for the objective SES measure, the range for

all items show that participants were using the entire scale. The results show similar means and standard deviations as in Study 1[1]. The results of the subjective measure show most of the data clustered around the centre of each scale. As can be seen, participants rated SES at age 0-5 years lower than SES age 5-18 or SES now.

4.3.1.2 Correlational and Factor Analysis of SES Measures

As a first step in the analysis, correlations of the SES measures were examined. As shown in Table 4.3, the SES items are moderately intercorrelated. Correlations are relatively strong between the subjective SES measures, and small to moderate between the objective SES measures. Additionally, there are weak but significant positive correlations between the measures of objective and subjective SES. Household income has the strongest correlation with the subjective measure at 5-18 years old.

To examine the underlying factor structure of the indicators of SES, an Exploratory Factor Analysis was performed on the variables after standardisation. Combining the results of the scree plot and eigenvalues, two factors were extracted, which in combination accounted for 57.35% of the variance in the data. The KMO

[1] Also comparably to Study 1, there was a high rate of *don't know* answers for the income variable (17.81%).

Table 4.2

Descriptive Statistics for the Subjective and Objective SES Items

Item	*N*	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Mother's Education *(1= no formal qualifications, 2= GCSE's or equivalent, 3= A-levels or equivalent, 4= post-18 qualification, 5= undergraduate degree, 6= postgraduate degree)*	139	3.14 (1.35)	3 (1-6)	.46	-.74
Father's Education *(as previous item)*	134	3.05 (1.44)	2 (1-6)	.63	-.78
Mother's Occupation *(1= unemployed, 2= full-time student or full-time parent; 3= elementary occupation; 4= process, plant, or machine operative; 5= sales or customer service occupation; 6= caring, leisure or other service occupation; skilled trades occupation; 7= administrative or secretarial position; 8= associate professional or technical occupation; 9= professional occupation; 10= manager, director or senior official)*	142	6.17 (2.86)	6 (1-10)	-.35	1.03
Father's Occupation *(as previous item)*	134	6.49 (3.03)	6 (1-10)	-.40	1.21
Household Income *(1= £0-£10,000; 2= £10,000-£20,000; 3= £20,000-£30,000; 4= £30,000-£40,000; 5= £40,000-£50,000; 6= £50,000-£60,000; 7= £60,000-£70,000; 8= £70,000-£80,000; 9=£80,000-£90,000; 10= £90,000-£100,000; 11= £100,000+)*	117	4.45 (2.49)	4 (1-11)	.96	.55
MacArthur scale: 0-5 years *1= lowest rating; 10= highest rating*	147	4.95 (1.89)	5 (1-10)	.14	-.51
MacArthur scale: 5-18 years *(as previous item)*	147	5.48 (1.56)	6 (2-10)	-.15	-.18
MacArthur scale: Now *(as previous item)*	147	5.43 (1.39)	5 (2-9)	.09	-.23

Note: s.d. = Standard Deviation

result of 0.70 suggested that the sampling is adequate and a significant Bartlett's test showed variables are unrelated, presenting that the data is suited to factor analysis. Table 4.4 presents the factor loadings of a principal component analysis after varimax rotation.

The items that cluster on the same factor suggest that factor 1 represents *Subjective SES* due to high loadings of the three subjective SES measures. The income variable was removed from this factor due to cross loading on both factors. Reliability analysis also confirmed a higher factor variance if this measure was removed. Factor 2 captures *Objective SES* due to the objective SES measures loading highly on this factor. Mother's occupation was removed from this factor due to a weak factor loading. The

factors found in this factor analysis are used in the subsequent analyses as measures of SES.

Table 4.3
Inter-item Correlations of Objective and Subjective SES variables

	1.	2.	3.	4.	5.	6.	7.	8.
1. Mother's Education								
2. Father's education	.41**							
3. Mother's occupation	.39**	.16						
4. Father's occupation	.24**	.44**	.15					
5. Household Income	.30**	.42**	.40**	.41**				
6. MacArthur SSS 0-5 years	.24**	.27**	.26**	.11	.21*			
7. MacArthur SSS 5-18 years	.29**	.30**	.36**	.25**	.58**	.67**		
8. MacArthur SSS Now	.23**	.21**	.20*	.30**	.43**	.41**	.68**	

*Note: *p<.05; **p<.01*

Table 4.4
Principal Component Analysis After Varimax Rotation for the SES Items

	Factor	
Variable	1	2
MacArthur SSS (ages 5-18)	**.90**	.25
MacArthur SSS (ages 0-5)	**.80**	.06
MacArthur SSS (Now)	**.76**	.21
Income	**.44**	**.62**
Father's education	.10	**.77**
Father's occupation	.05	**.74**
Mother's education	.19	**.64**
Mother's occupation	.36	**.40**
Eigenvalues	2.39	2.20
% of variance	29.81	27.53
α	.73	.67

Note: MacArthur SSS = MacArthur scale of subjective social status

4.3.2 Analyses of Language Exposure Measures

This section will examine the measures of written and spoken language exposure. Descriptive statistics for each measure will be discussed first, followed by correlational analyses to explore relationships between the measures. Finally, a factor analysis will be used to assess the factor structure of the measures.

4.3.3.1 Descriptive Statistics of the Language Exposure Measures

Reading Habits: Table 4.5 presents descriptive statistics for the Reading Habits section of the questionnaire, the first measure used to examine written language exposure. The range shows that for all items, participants used the entire scale. Skewness and kurtosis suggest that the results for items in this section are normally distributed. Similar to Study 1, participants reported reading on average three to ten books per year and reported visiting bookstores several times a year. Participants also reported having an average of 51 to 80 books in their family home.

Table 4.5
Descriptive Statistics for the Reading Habits Section of the Questionnaire (N=147)

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Number of books read in a year *(Not including academic material; 1= none; 2= one or two, 3= 3-10, 4= 11-20, 5= 21-40, 6= 40+)*	2.89 (1.12)	3 (1-6)	.54	.56
Frequency of bookstore visits *(1= never, 2= once or twice a year, 3= several times a year, 4= once or twice a month, 5= once or more a week)*	2.71 (1.06)	3 (1-5)	.07	-.62
Frequency of online bookstore visits *(as previous item)*	2.67 (1.30)	3 (1-5)	.26	-1.03
Number of books in family home *(1= none, 2= 1-10, 3= 11-30, 4= 21-50, 5= 51-80, 6= 81-150, 7= 150-200, 8= 200+)*	5.12 (1.88)	5 (1-8)	.01	-.98

Note: s.d. = Standard Deviation

Reading Time: Reading time is the second measure of written language exposure that focused on self-reported time spent reading different types of materials. As can be seen from the mean scores in Table 4.6, participants reported spending two to three hours a week reading fiction books, textbooks, and academic materials, and approximately the same amount of time reading email and internet media. In contrast, participants in this sample report spending by far most time (on average five hours) reading content on social media. These findings are also similar to what was found in Study 1.

Table 4.6
Descriptive Statistics for the Reading Time Section of the Questionnaire (N=147)

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Time spent reading content on social media *(1= 0hours, 2= 1hour, 3= 2hours, 4= 3hours, 5= 4hours, 6= 5hours, 7= 6hours, 8= 7+ hours per week)*	6.21 (2.11)	7 (1-8)	-.85	-.54
Time spent reading academic material other than textbooks *(as previous item)*	4.07 (2.26)	4 (1-8)	.45	-.91
Time spent reading textbooks *(as previous item)*	3.78 (2.25)	3 (1-8)	.49	-.84
Time spent reading e-mail *(as previous item)*	3.62 (1.92)	3 (1-8)	.99	.02
Time spent reading fiction books *(as previous item)*	3.20 (2.30)	3 (1-8)	.87	-.39
Time spent reading newspapers *(as previous item)*	3.03 (1.82)	2 (1-8)	1.12	.49
Time spent reading internet media *(as previous item)*	2.74 (1.78)	2 (1-8)	1.34	1.45
Time spent reading non-fiction/special interest books *(as previous item)*	2.27 (1.52)	2 (1-8)	1.38	1.63

Note: s.d. = Standard Deviation

Comparative Reading Habits: The CRH measure is the third measure of written language exposure where participants self-reported their reading habits compared to other people their own age. Table 4.7 shows descriptive statistics for the CRH measure. As in Study 1 and in the original study using this measure (Acheson et al., 2008), mean scores for CRH questions show that, on average, participants rate themselves as about the same as others for all types of reading. Interestingly, and as in Study 1, participants rate themselves as enjoying reading slightly more than others.

Table 4.7
Descriptive Statistics for the Comparative Reading Habits Section of the Questionnaire (N=147)

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
CRH time spent reading academic material *(Compared to others of the same age; 1= much less than others, 2= less than others, 3= about the same as others, 4= more than others, 5= much more than others)*	3.11 (.94)	3 (1-5)	-.02	.28
CRH time spent reading fiction *(as previous item)*	3.02 (1.23)	3 (1-5)	-.15	-1.06
CRH time spent reading newspapers and magazines *(as previous item)*	2.79 (1.02)	3 (1-5)	-.12	-.61
CRH complexity of non-academic material *(as previous item)*	3.10 (.81)	3 (1-5)	.06	1.10
CRH enjoyment of reading *(as previous item)*	3.51 (1.14)	4 (1-5)	-.51	-.39
CRH time spent on social media *(as previous item)*	2.92 (.86)	3 (1-5)	.03	.45

Note: s.d. = Standard Deviation

ART: The final measure of written language exposure used is the ART (see Table 4.8 for descriptive statistics). Scores for the ART showed that participants correctly identified on average 13 out of a total of 40 authors, which is slightly higher than Study 1 (M = 11.35) and similar to the proportion of authors correctly identified in Acheson et al. (2008, M = 23 out of 65). Mean false alarm rates were less than 2 suggesting that guessing was low. An examination of the results of literary and popular authors separately showed a higher mean number of correct targets checked for literary authors compared to popular authors, similar to Study 1 (mean for literary authors = 6.80, mean for popular authors = 4.55). Selection rates for authors, split into literary and popular authors, are presented in Appendix 10. Selection rates ranged from 1% to 88%.

Table 4.8

Descriptive Statistics for the Author Recognition Test (N=147)

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Targets checked[1]	12.94(5.77)	12 (24)	.39	-.50
Incorrect targets checked[2]	1.97 (1.70)	1.5 (9)	3.38	14.21
Corrected score *Targets checked - incorrect targets checked*	10.97(5.72)	10 (25)	.58	-.05
Literary authors targets checked[3]	7.26 (3.77)	7 (18)	.55	.17
Literary authors corrected score *Literary targets checked - half of total incorrect targets checked*	7.08 (3.54)	7 (17)	.61	1.52
Popular authors targets checked[4]	4.53 (3.07)	4 (14)	.86	.24
Popular authors corrected score *Popular targets checked - half of total incorrect targets checked*	4.04 (3.15)	3 (11)	.50	-.78

Note: s.d. = Standard Deviation; [1]Total number of items=40; [2]Total number of items=40; [3]Total number of items=20; [4]Total number of items=20

Comparative Spoken Language Exposure: In Study 2, only one set of measures was used to examine spoken language exposure, in which participants self-reported their spoken language exposure relative to people their own age (see Table 4.9 for descriptive statistics). The first two questions were not comparative, and they asked participants to report time spent per day verbally interacting with others and listening to spoken language. Scores show that respondents report spending between one hour and several hours per day verbally interacting and listening to spoken language. This is similar to the analogous items in Study 1. The other questions in this section asked participants how much time they spend in various spoken language contexts compared to their peers. Participants report they spend about the same amount of time as others in most spoken contexts, such as talking with friends and family, instant messaging, watching tv shows/films and online video clips, yet participants report listening to music more than others. Relatively less time is spent texting, talking to others whilst playing online games and listening to podcasts and audiobooks, compared to others.

Table 4.9
Descriptive Statistics for the Spoken Language Exposure Section of the Questionnaire (N=147)

Item	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Time spent verbally interacting with others (*1= never, 2= 1 hour or less a week, 3= 2 to 5 hours a week, 4=1 hour or less a day, 5= several hours a day*	4.80 (.56)	5 (2-5)	-2.94	8.11
Time spent listening to spoken language *(as previous item)*	4.32 (1.05)	5 (1-5)	-1.51	.40
Comparative time spent talking with friends *(Compared to others of the same age; 1= much less than others, 2= less than others, 3= about the same as others, 4= more than others, 5= much more than others)*	3.10(.77)	3 (1-5)	-.37	.89
Comparative time spent talking with family *(as previous item)*	3.17 (1.09)	3 (1-5)	-.22	-.59
Comparative time spent instant messaging *(as previous item)*	3.01 (.91)	3 (1-5)	.03	.02
Comparative time spent texting *(as previous item)*	2.42 (.91)	2 (1-5)	.21	-.49
Comparative time spent talking to others whilst playing online games *(as previous item)*	1.50 (1.08)	1 (1-5)	2.17	3.95
Comparative time spent watching TV shows/films *(as previous item)*	3.07 (.96)	3 (1-5)	-.10	.00
Comparative time spent watching online video clips *(as previous item)*	3.09 (1.17)	3 (1-5)	-.12	-.92
Comparative time spent listening to music (with lyrics) *(as previous item)*	3.59 (1.02)	4 (1-5)	-.43	-.19
Comparative time spent listening to podcasts *(as previous item)*	2.35 (1.31)	2 (1-5)	.57	-1.02
Comparative time spent listening to audiobooks *(as previous item)*	1.61 (1.02)	1 (1-5)	1.85	2.85

Note: s.d. = Standard Deviation

Comparative Sentence Familiarity Rating Task: A sentence structure familiarity rating task was included as a measure of language exposure that specifically targets the sentence structures examined in the online sentence comprehension and production tasks. Descriptive statistics for the comparative sentence familiarity rating task are shown in Table 4.10. As can be seen from the mean rating for each structure, and as expected, active sentences were rated as more familiar than passives. Similarly, ORCs were rated more familiar than PRCs, as in Study 1.

In order to test whether there was a statistically significant difference in the rating between different structures in the comparative rating task, t-test analyses were conducted. Active sentences were rated as more familiar than passive sentences ($t(147) = 17.27$, $p<0.001$). Similarly, there was a significant difference in familiarity rating between PRCs and ORCs ($t(147) = 21.22$, $p<0.001$), with ORCs being rated as more familiar. This is a similar pattern as found in Study 1, and similar to the corpus analyses reported by Montag and MacDonald (2015).

Table 4.10
Descriptive Statistics for the Items in the Comparative Familiarity Rating Task (N=147)

Item	Example Sentence	Mean (S.D.)	Median (Range)	Skewness	Kurtosis
Active *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The organisers described the event.	5.56 (.70)	5.62 (3-7)	-.43	.72
Passive *(as previous item)*	The event was described by the organisers.	4.30 (.79)	4.38 (2-6)	-.18	-.57
Passive relative clause *(as previous item)*	The planet that was hit by the asteroid contained life.	3.73 (.75)	3.67 (2-7)	.27	.41
Object relative clause *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The planet that the asteroid hit contained life.	5.34 (.64)	5.40 (2-7)	-.80	1.65
Ditransitive *(1 very rarely, 2, 3, 4 sometimes, 5, 6, 7 very often)*	The teacher gave the students a test. The teacher gave a test to the students.	5.13 (.65)	5.06 (3-7)	.15	-.43

Note: S.D = Standard Deviation

4.3.2.2 Correlational Analysis of Language Exposure Measures

To further examine relationships between language exposure measures, correlational analyses were run first. This analysis included all self-report measures (Reading Habits, Comparative Reading Habits, Reading time, Comparative Spoken Language Exposure) and ART. Due to some of the variables showing deviations from the normal distribution, non-parametric correlations were run between exposure items, which are shown in Table 4.11.

In general, items from within each section of the questionnaire were moderately to highly intercorrelated. Reading habits and CRH showed stronger within item intercorrelations than Reading Time and Comparative Spoken Exposure, and they also showed correlations with the items measuring similar types of text across the different measures. The correlations found in Study 1 showed a clear dissociation between reading for academic and non-academic purposes. In the current study, the relationships between reading for academic and non-academic purposes were stronger than in Study 1. However, the correlations were stronger within each group of academic and non-academic items compared to between the two types of reading. For example, correlations between CRH academic material and time spent reading textbooks and academic material were r= .45 and r= .55 respectively. In the same way, correlations showed time spent reading fiction and CRH enjoyment of reading to be highly correlated (r= .71). Conversely, the correlation between CRH academic material and time spent reading fiction was r= .16. Reading Time items had medium to strong correlations with the relevant Reading Habits and CRH items.

Interestingly, measures of internet media, social media, and email while intercorrelated, showed few correlations with measure of fiction and non-fiction reading. Moreover, social media use was weakly negatively correlated with time spent

reading academic materials. Time spent reading textbooks was also negatively correlated with time spent watching TV, films, and shows, and time spent listening to music.

Comparative spoken language items had fewer and weaker intercorrelations, but time spent listening to podcasts and audiobooks was correlated with fiction reading, reading of academic materials, and enjoyment of reading. The spoken language measures generally did not correlate with the reading habits measures, apart from time spent listening to audiobooks and podcasts. Additionally, the few significant relationships between the spoken language measures were weak.

There were significant correlations between the ART and other reading habits variables. For example, the ART significantly correlated with number of books read, frequency of bookstore visits, CRH enjoyment of reading, CRH fiction, and time spent reading fiction. These correlations are higher than in Study 1 and support previous studies that have used the ART alongside a reading habits questionnaire (Acheson et al., 2008).

Table 4.11

Inter-item Correlations of Language Exposure Items (N=147)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. RH Number of books read in a year															
2. RH Frequency of bookstore visits	**.61****														
3. RH Frequency of online bookstore visits	**.62****	**.45****													
4. RH Number of books in family home	**.49****	**.39****	**.33****												
5. CRH Time spent reading academic material	**.36****	**.36****	**.26****	**.20***											
6. CRH Time spent reading fiction	**.67****	**.53****	**.49****	**.34****	**.24****										
7. CRH Time spent reading newspapers/ magazines	-.03	-.03	.08	-.06	.11	-.05									
8. CRH Complexity of non-academic material	**.32****	.16	**.28****	**.15**	**.28****	**.19***	**.17***								
9. CRH Enjoyment of reading	**.69****	**.55****	**.52****	**.40****	**.33****	**.78****	.05	**.32****							
10. CRH Time spent on social media	-.15	-.04	-.03	**-.20***	**-.17***	.01	.02	-.15	-.08						
11. RT Time spent reading textbooks	**.20***	**.28****	**.27****	.06	**.45****	.08	.08	.09	**.23****	-.11					
12. RT Time spent reading academic material	**.26****	**.27****	**.30****	.09	**.55****	.12	.14	.13	**.31****	-.01	**.48****				
13. RT Time spent reading fiction	**.70****	**.53****	**.53****	**.41****	.16*	**.77****	-.04	.15	**.71****	-.15	**.18***	.14			
14. RT Time spent reading non-fiction/special interest	**.38****	**.35****	**.30****	**.29****	**.20***	**.19***	.15	.16	**.26****	-.07	**.18***	.08	**.28****		
15. RT Time spent reading newspapers	**.20***	.13	**.19***	.16	.14	.03	**.57****	**.20****	**.19***	.07	.13	**.19***	.12	**.28****	
16. RT Time spent reading e-mail	.05	.04	.05	-.10	.02	.01	.07	.07	.13	.12	.04	**.21***	.04	-.02	**.27****
17. RT Time spent reading content on social media	-.10	-.11	.002	-.12	**-.18***	-.06	.01	-.07	-.02	**.53****	-.07	.09	-.12	-.02	.05
18. RT Time spent reading internet media	.04	.09	.15	.07	.05	-.003	**.22****	-.01	.10	.14	.13	.13	.10	**.23****	**.39****
19. ART	**.43****	**.37****	**.34****	**.36****	**.25****	**.44****	.15	**.31****	**.46****	.11	.06	**.24****	**.36****	**.26****	**.35****
20. Comparative time spent talking with friends	-.07	**-.17***	.04	-.03	-.03	-.16	.01	.01	-.09	.12	-.03	.02	-.08	-.02	-.03
21. Comparative time spent talking with family	.13	.08	.15	.04	.06	**.17***	-.01	-.01	.13	.12	.08	.06	.07	-.04	-.09
22. Comparative time spent instant messaging	-.04	-.08	.001	-.16	-.13	-.10	.08	-.15	-.09	**54****	-.05	.13	-.13	-.09	.02
23. Comparative time spent texting	.02	-.02	.05	-.02	-.13	.09	.06	.02	-.04	.13	-.10	**-.22****	.04	-.01	.03
24. Comparative time spent talking to others while playing online video games	-.05	.02	-.10	.05	.06	-.07	.03	-.10	-.06	-.06	-.02	-.03	-.05	-.01	.13
25. Comparative time spent watching TV shows/films	.05	.09	.09	.07	-.11	.13	.09	-.06	.09	**.27****	**-.20***	-.03	.06	-.10	.06
26. Comparative time spent watching online video	.08	.13	.13	.10	.04	.08	.08	-.02	.09	**.22****	.01	.04	.02	.07	**.17***
27. Comparative time spent listening to music	.05	.08	.02	.13	-.03	**.19***	-.06	.03	.13	.10	**-.17***	-.03	.12	-.01	-.01
28. Comparative time spent listening to podcasts	**.23****	**.20***	**.25****	.19	**.35****	**.25****	**.27****	.15	**.29****	.03	**.24****	**.27****	.15	**.17***	**.28****
29. Comparative time spent listening to audiobooks	**.26****	.13	**.23****	.07	**.22****	**.33****	.05	.14	**.25****	-.07	.11	.15	**.27****	.06	.09
30. Time spent verbally interacting with others	-.03	-.02	-.10	.05	.09	-.03	.11	.03	-.02	.04	-.01	.09	.06	-.11	**.21****
31. Time spent listening to spoken language	.15	.08	.12	.04	-.09	.05	.12	-.03	.06	.11	**-.17***	-.09	.004	.13	**.19***

*Note: RH= Reading Habits; CRH= Comparative Reading Habits; RT= Reading Time; ART= Author Recognition Test; *p*<.05*; **p*<.01

Table 4.11
Continued

	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.
1. RH Number of books read in a year																
2. RH Frequency of bookstore visits																
3. RH Frequency of online bookstore visits																
4. RH Number of books in family home																
5. CRH Time spent reading academic material																
6. CRH Time spent reading fiction																
7. CRH Time spent reading newspapers and magazines																
8. CRH Complexity of non-academic material																
9. CRH Enjoyment of reading																
10. CRH Time spent on social media																
11. RT Time spent reading textbooks																
12. RT Time spent reading academic material																
13. RT Time spent reading fiction																
14. RT Time spent reading non-fiction/special interest																
15. RT Time spent reading newspapers																
16. RT Time spent reading e-mail																
17. RT Time spent reading content on social media	**.31****															
18. RT Time spent reading internet media	**.25****	**.23****														
19. ART	.13	.12	.13													
20. Comparative time spent talking with friends	.11	.13	.04	-.15												
21. Comparative time spent talking with family	.06	.09	.07	.01	**.17***											
22. Comparative time spent instant messaging	.14	**.38****	.07	.02	**.23****	.10										
23. Comparative time spent texting	.08	.06	.10	.04	-.02	**.22****	**.24****									
24. Comparative time spent talking to others while playing online video games	.04	-.11	-.05	-.10	-.08	-.07	-.02	-.03								
25. Comparative time spent watching TV shows/films	.09	.11	-.04	**.20***	.04	**.19***	**.26****	**.18***	.001							
26. Comparative time watching online video clips	-.004	**.19***	.15	.07	-.03	-.04	.11	.01	.11	**.18***						
27. Comparative time spent listening to music	-.10	.03	-.03	.12	-.04	-.01	**.19***	.11	-.02	.07	**.20***					
28. Comparative time spent listening to podcasts	-.09	.03	.10	**.32****	-.06	-.08	-.09	-.05	.05	.07	**.34****	.03				
29. Comparative time spent listening to audiobooks	.04	.05	.05	**.17***	-.11	.04	**-.19***	.01	-.03	.01	.11	-.07	**.40****			
30. Time spent verbally interacting with others	.09	.04	.04	.06	**.24****	-.09	.04	.01	.02	-.05	-.09	.08	.04	.04		
31. Time spent listening to spoken language	-.002	.10	.15	**.22****	-.15	.04	.09	.11	.00	**.34****	**.19***	.07	.13	.11	.13	

*Note: RH= Reading Habits; CRH= Comparative Reading Habits; RT= Reading Time; ART= Author Recognition Test; *p*<.05*; **p*<.01

4.3.2.3 Factor Analysis of Language Exposure Measures

To further analyse the language exposure measures, a factorial analysis was conducted. In order to assess which measures group together, and whether a similar factor structure was found as in Study 1, data for all items in the Reading Habits, Reading Time, CRH, and Comparative Spoken Exposure measures were standardised, and an Exploratory Factor Analysis (EFA) was performed. Combining the result of the scree plot and eigenvalues, five factors were extracted, which in combination, accounted for 43.33% of the variance in the data. The KMO result of 0.73 suggested that the sampling is adequate and a significant Bartlett's test showed variables are unrelated, presenting that the data is suited to factor analysis. Table 4.12 presents the factor loadings of a principal component analysis after varimax rotation.

The results show that factor 1 captures *recreational reading*, with high loadings of variables such as number of books read in a year, time spent reading fiction, enjoyment of reading, and frequency of bookstore visits, with the addition of number of books in the family home. This factor has a similar structure to that found in Study 1. Factor 2 in the current study represents *social media use* due to time spent reading content on social media and instant messaging loading highly on this factor. Unlike Study 1, this factor does not load on the communicative items from the Spoken Language Exposure measure (e.g., times spent texting, time spent talking with family). Factor 3 is similar to Study 1, and it includes time spent reading academic material and textbooks, suggesting this factor represents *reading for academic purposes*. Factor 4 represents *information exposure*, similar to Study 1, due to the factor containing time spent reading newspapers, magazines and non-fiction, and complexity of non-academic material. Finally, factor 5 captures an aspect of *spoken language*, and includes time spent talking with family, watching tv shows/films, and texting. A separate spoken

Table 4.12
Principal Component Analysis After Varimax Rotation for Language Exposure Items (N=147)

Variable	Factor 1	2	3	4	5
RH Number of books read in a year	**.86**	-.07	.11	.06	.06
RT Time spent reading fiction	**.82**	-.07	-.06	-.05	.01
CRH Time spent reading fiction	**.81**	-.01	.03	-.08	.12
CRH Enjoyment of reading	**.78**	-.01	.24	.08	.02
RH Frequency of bookstore visits	**.72**	-.03	.24	.02	-.07
RH Frequency of online bookstore visits	**.69**	.07	.20	.10	.13
RH Number of books in family home	**.62**	-.17	-.01	.08	.03
CRH Time spent on social media	-.08	**.82**	-.08	-.001	.16
RT Time spent reading content on social media	-.08	**.82**	-.05	.04	-.02
Comparative time spent instant messaging	-.13	**.62**	.10	-.05	.35
RT Time spent reading academic material	.12	.11	**.82**	.07	-.04
CRH Time spent reading academic material	.22	-.19	**.77**	.17	-.06
RT Time spent reading textbooks	.14	-.03	**.69**	.01	-.14
RT Time spent reading newspapers	.13	.08	.02	**.84**	-.10
CRH Time spent reading newspapers and magazines	-.12	-.04	.13	**.76**	.18
RT Time spent reading non-fiction/special interest	**.43**	.14	.03	**.44**	-.30
CRH complexity of non-academic material	.26	-.21	.24	**.41**	.01
Comparative time spent talking with family	.15	.08	.11	-.14	**.63**
Comparative time spent watching TV shows/films	.10	.19	-.16	.04	**.62**
Comparative time spent texting	.03	.04	-.21	.13	**.57**
Comparative time spent listening to audiobooks	.27	-.01	.10	-.01	.08
Comparative time spent listening to podcasts	.18	.08	.35	.39	.08
Comparative time spent talking with friends	-.12	.17	.13	-.01	.30
Time spent verbally interacting with others	.09	-.08	.02	-.10	.19
RT Time spent reading email	.05	.20	.01	.27	-.07
RT Time spent reading internet media	.12	.37	.11	.26	-.01
Comparative time spent listening to music	.15	.16	-.04	-.06	.09
Comparative time spent talking to others while playing online games	-.05	-.16	.02	.05	-.07
Comparative watching online video clips	.08	.37	.04	.19	.06
Time spent listening to spoken language	-.03	-.09	-.05	-.03	-.03
Eigenvalues	4.65	2.35	2.26	2.11	1.62
% of variance	15.50	7.84	7.54	7.04	5.41
α	.86	.65	.64	.60	.45

Note: CRH= Comparative Reading Habits; ART = Author Recognition Test

language factor was not found in the factor analysis conducted in Study 1. The format of the spoken language questions was changed for Study 2 to present them in a comparative way, which produced measures that were more strongly intercorrelated resulting in a separate spoken language factor.

Due to the unexpected results with ART in Study 1 that were inconsistent with the previous literature, ART was not included in the factor analysis. Instead, separate

correlation analyses were run between ART and the factors identified in the factor analysis. Correlational analyses in Table 4.13 show a moderate correlation between the ART and the *recreational reading* factor and *information exposure* factor. Based on previous research (e.g. Acheson et al., 2008), it would be expected that ART would correlate with *recreational reading* due to the factor including variables such as time spent reading fiction, enjoyment or reading, frequency of bookstore visits, and number of books in the home. The ART is a list of fiction authors, and so it would be expected that those that read more fiction would recognise more fiction authors names (Stanovich & West, 1989). In Study 1, the ART was included in the factor analysis together with the other exposure measures, and it loaded with CRH time spent reading newspapers and magazines, which is included in the *Information Exposure* factor in this study. The ART significantly correlates with the *Information Exposure* factor in the current study showing that there is also a relationship between these variables.

Table 4.13
Correlations Between the ART and Language Exposure Factors (N=147)

	1.
1. ART	
2. Recreational Reading	**.43****
3. Social Media Use	.09
4. Reading for Academic Purposes	.12
5. Information Exposure	**.38****
6. Spoken Language	.01

*Note: ART = Author Recognition Test; *p<.05; **p<.01*

Correlational analyses were also run to examine the relationship between the comparative sentence familiarity rating task and the factors of language exposure. This task was created as an indirect measure of language exposure, assuming that an individual's familiarity with a syntactic structure is related to the amount of exposure the individual has with that structure. As passives and PRC structures are more common in written language (e.g. Montag & MacDonald, 2015; Roland et al., 2007) it can be

hypothesised that the rated familiarity of these structures would correlate with ART and *recreational reading* or *reading for academic purposes*. However, this was not the case, as seen in Table 4.14. The ART was correlated with familiarity ratings of actives and ORCs. Additionally, *social media use* significantly correlated with ORC familiarity, which was also found in Study 1. This suggests that more time spent interacting with social media, the higher familiarity with ORCs. To the extent that social media use reflects spoken language, this finding would be consistent with a higher frequency of exposure to ORCs in spoken language (e.g. Montag & MacDonald, 2015; Roland et al., 2007).

Table 4.14
Correlations Between the Comparative Sentence Familiarity Task and Language Exposure Factors (N=147)

	1.	2.	3.	4.	5.
1. Mean Active familiarity [1]					
2. Mean Passive familiarity [2]					
3. Mean ORC familiarity [3]					
4. Mean PRC familiarity [4]					
5. Mean Ditransitive familiarity [5]					
6. ART	**.18***	.14	**.21***	.06	.12
7. Recreational Reading	.15	.10	.02	.07	.07
8. Social Media Use	.10	.01	**.18***	.06	.05
9. Reading for Academic Purposes	.02	-.03	-.09	-.13	-.06
10. Information Exposure	-.05	.09	.05	.05	.001
11. Spoken Language	.03	-.02	.01	.08	-.04

*Note: *p<.05; **p<.01; ORC= Object Relative Clause; PRC= Passive Relative Clause; ART = Author Recognition Test; [1]Mean of all active sentences in the comparative rating task; [2]Mean of all passive sentences in the comparative rating task; [3]Mean of all ORCs in the comparative rating task; [4]Mean of all PRCs in the comparative rating task; [5]Mean of all ditransitive sentences in the comparative rating task.*

In sum, the analyses of the measures of language exposure produced results similar to Study 1. The factor analysis resulted in five factors, with the first four factors having a similar factor structure as in Study 1. These factors captured *recreational reading*, *social media use*, *reading for academic purposes*, and *information exposure*. With a new, comparative, measure of spoken language exposure, a separate *spoken*

language factor emerged which captured some aspects of spoken language exposure (talking with family, texting, and watching films and TV shows). Similar to Study 1, ART was positively related to the *information exposure* factor, but unlike Study 1, and similar to previous research, ART did correlate with *recreational reading*. Sentence structures rated for familiarity in the Comparative Sentence Familiarity Rating Task did not show many correlations with the exposure factors. One exception was a positive correlation between the ORC familiarity and social media use. ART was also positively correlated with the familiarity of actives and ORCs.

4.3.3 Analyses of Language Use Measures

In the following section, the analyses of the language use measures will be presented. The first set of analyses will focus on the replication of the original findings from the two measures of sentence processing: the Wells et al. (2009) study for sentence comprehension, and the Montag and MacDonald (2015) study for online sentence production. The subsequent sections will then present the descriptive statistics and correlational analyses for all language use measures.

4.3.3.1 Replication of Wells et al. (2009) Sentence Comprehension Experiment

For the sentence comprehension task, the data were first assessed for the replication of the key findings in the original study. For these analyses, and as in the original study, data were excluded for participants whose mean accuracy on all trials was below 75%, removing the data for 35 participants. This is a similar proportion as in the original study (Wells et al., 2009). In addition to this, two errors in the experiment script resulted in further data being removed. First, data for one experimental item, including the ORC and SRC version in the two lists, was removed for each participant.

Therefore, data for each participant consisted of 19 experimental trials rather than 20 trials. Second, an error in the setup of the experimental script for one of the lists affected 38 participants' data. In order to keep an equal number of participants in each list for the purposes of the replication analysis, the data for 45 participants chosen randomly from the unaffected list were removed. Therefore, the final dataset for this analysis included 52 participants, 26 in each list.

4.3.3.1.1 Accuracy

Accuracy rates for the comprehension question, for each sentence type, are shown in Table 4.15. As expected, accuracy was higher for SRCs compared to ORCs. This follows the results for accuracy in the original study, however accuracy rates were slightly lower in the current study (.76–.83 for the experimental items in Wells et al., 2009). A paired samples t-test analysis was conducted for the experimental items and showed a significant difference between accuracy scores for relative clause type, $t(51) = 3.05$, $p=.004$, confirming significantly higher accuracy for the easier SRCs.

Table 4.15
Mean Proportion Correct and Standard Deviations for Comprehension Questions for Subject Relative Clauses, Object Relative Clauses, and Filler Items (N=52)

	Mean (s.d.)
Subject relative clauses	.75 (.10)
Object relative clauses	.70 (.11)
Fillers	.88 (.04)

Note: s.d. = Standard deviation

4.3.3.1.2 Self-paced reading times

As in the original study, reading time analyses were conducted only on trials for which the comprehension question was answered correctly. Additionally, raw reading

times per word that were greater than 2000ms were removed. Length adjusted reading time was calculated using unstandardised residuals from regression analyses for each participant predicting reading time per word based on length (in number of characters). Length adjusted reading times that were more than 2.5 standard deviations from the mean reading time per word were replaced with the cut-off value. As in the original study, data were then grouped into four regions, with the main verb positioned in region 3. This is represented in Figure 4.3, which shows length adjusted reading times for relative clause sentences. Means for unadjusted reading times are provided in Appendix 25.

The same analysis as in the original study was run to examine the effects of relative clause type and region. A two-way within-subjects ANOVA showed a significant main effect of relative clause type ($F(1,680) = 18.41$, $p=.001$) and Region ($F(2.34, 1594.19) = 51.29$, $p=.001$), with overall slower reading times for ORCs. Additionally, a significant interaction was found ($F(2.26, 1538.90) = 9.34$, $p=.001$) with the difference in the two sentence structures in regions 2 and 3. These results replicate the findings in Wells et al. (2009), with slower reading times for the more difficult (and less frequent) ORC structures centred around the main verb. In the current sample, the difficulty was additionally found at an earlier time point (region 2). This could suggest that participants were anticipating the main verb. Accuracy for comprehension question and reading time at the main verb (region 3) was used in subsequent analyses.

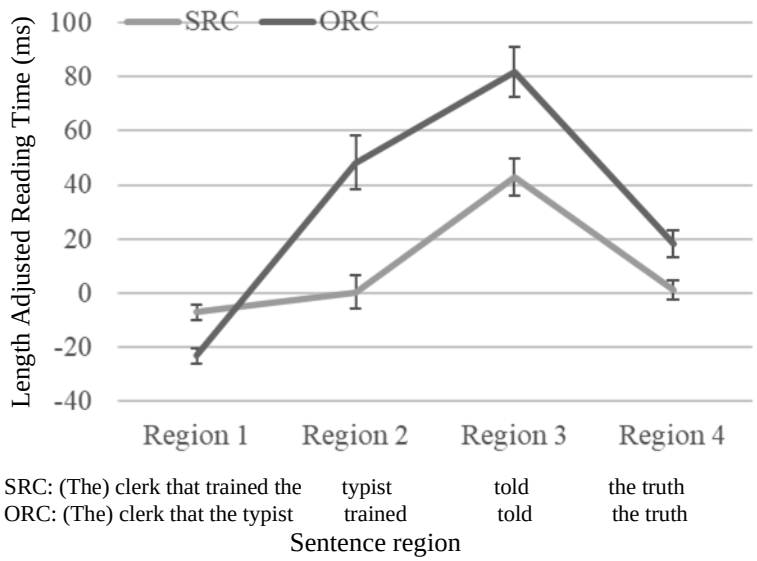

Figure 4.3
Length-adjusted Reading Times for Subject and Object Relative Clauses (N=52)

4.3.3.2 Replication of Montag & MacDonald (2015) Sentence Production Experiment

For the following sentence production replication analyses, the same analyses were performed as in the original study. Individual data points were excluded if responses did not contain a relative clause. Exclusions included missing responses, inaccurate responses that did not identify the target correctly, and responses that used a structure other than a relative clause. In total, 885 trials were removed; 12.5% animate and 18.1% inanimate. Therefore, 2015 trials were analysed. As stated in Montag & MacDonald (2015), participants were not explicitly told what type of sentence to use and therefore not every trial included a relative clause. The remaining responses were then coded as an object or passive relative clause, with passive relative clauses further coded as get-passive, such as *the boy <u>getting</u> kicked by the girl*, or be-passive, such as *the boy <u>being</u> kicked by the girl*.

The data were analysed using a mixed effects logistic regression in R (glmer function in lme4, Bates, Mächler, Bolker, & Walker, 2014). As in the original study,

the first analysis assessed the effect of animacy on passive and active relative use, with participants and items included as random effects for intercepts and slopes. The results showed a significant effect of animacy on structure choice (Table 4.16). As illustrated in Figure 4.4, participants used more passive than object relative clauses in response to animate targets. Figure 4.4 shows that passive relative clauses, including both get-passives and be-passives, are produced most when describing an animate target. This result replicates the result of the original study.

Table 4.16
Mixed-effects Logistic Model Predicting Structure Choice by Animacy of Target Noun (N=134)

	Coefficient	SE	*z*	*p*
Intercept	3.12	0.40	7.70	$p < .001$
Animacy	2.25	0.33	6.83	$p < .001$

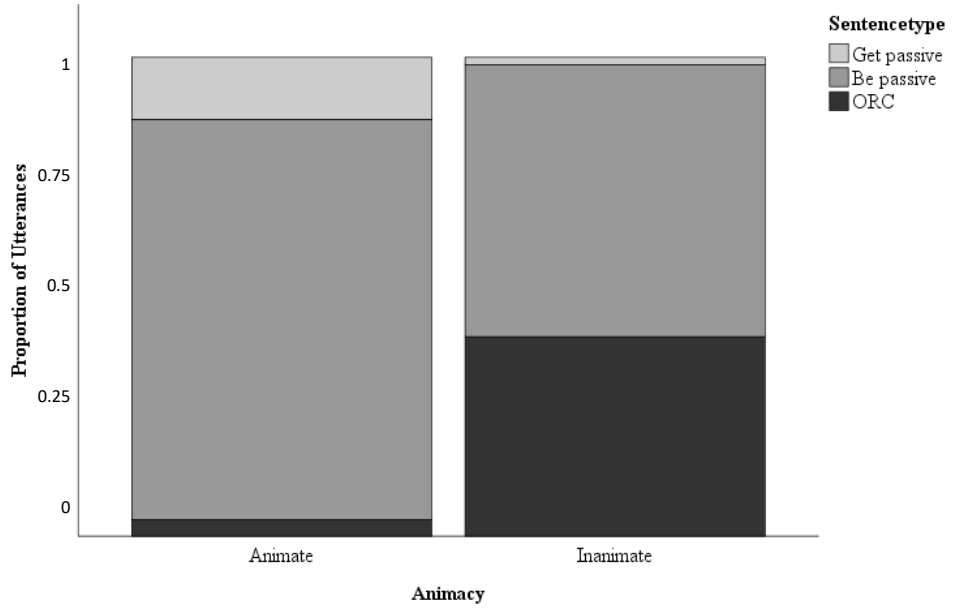

Figure 4.4
Proportion of Get-passive, Be-passive and Object Relative Clause Utterances, Split by Animacy (N=147)

Montag and MacDonald (2015) also showed that the type of passive relative clause produced was predicted by animacy. Analyses were conducted on passive relatives to predict whether individuals produced more be-passives (coded as 1 in this

analysis) or get-passives (coded as 0) based on animacy of the target noun. Table 4.17 shows individuals produced significantly more be-passives than get-passives when the target noun was animate, which replicates the result found in Montag and MacDonald (2015).

Table 4.17
Mixed-effects Logistic Model Predicting Structure Choice of Be-passives by Animacy of Target Noun (N=134)

	Coefficient	SE	*z*	*p*
Intercept	4.74	0.74	6.37	$p < .001$
Animacy	-1.90	0.78	-2.45	0.01

In the final analyses, the contribution of written language exposure to passive and active relative clause (ORC) choice was examined. As in the original study, ART was used as a measure of written language exposure. *Recreational reading* was also used as an additional measure of written language exposure, although this was not done in the original study. Table 4.18 summarises the third model in which the animacy effect was replicated, but language exposure (as measured by the ART in the first model and *recreational reading* in the second model) did not predict production choices. This finding only partially replicates the original study which found a small but significant contribution of ART as a measure of written language exposure on production choices. The relationship between language exposure and sentence production will be further explored in the regression analyses below.

In sum, the key experimental effects reported in the two measures of online sentence processing (comprehension and production) were replicated in the current study. However, no relationships were found between production choices and two measures of written language exposure.

Table 4.18
Mixed-effects Logistic Model Predicting Structure Choice by Animacy of Target Noun and Language Exposure (ART and Recreational Reading; N=134)

	Coefficient	SE	z	*p*
Intercept	3.11	0.40	7.71	*p* <.001
Animacy	2.24	0.33	6.85	*p* <.001
ART	0.01	0.03	0.18	0.86
Animacy x ART	-0.01	0.03	-0.43	0.67
Intercept	3.11	0.40	7.71	*p* <.001
Animacy	2.24	0.33	6.84	*p* <.001
Recreational reading	0.06	0.18	0.35	0.73
Animacy x Recreational reading	-0.06	0.15	-0.40	0.69

Note: SE = Standard Error

4.3.3.3 Descriptive Statistics and Correlational Analysis for Language Use Measures

Several measures were used in the current study to measure different aspects of language use: vocabulary, language comprehension (at sentence and passage level), and sentence production. For vocabulary, corrected percent score on the LexTALE lexical decision task was used as a measure of vocabulary breadth, and percent correct score on the Nelson-Denny synonyms task as a measure of vocabulary depth. For language comprehension, percent correct score on the Nelson-Denny comprehension task was used as a measure of passage comprehension, and difference scores for comprehension accuracy (SRC and ORC) and difference in reading time at the main verb (SRC and ORC) were used as measures of sentence comprehension. Lastly, for sentence production, proportion difference of relative clauses produced (SRC and ORC) was used as a measure of online sentence production, and standard scores from the CELF-5 recalling sentences subtest was used as a second measure of production. Table 4.19 presents descriptive statistics for the language use measures.

Table 4.19
Descriptive Statistics for the Language Use Measures

Item	*N*	Mean (s.d.)	Median (range)	Skewness	Kurtosis
Vocabulary depth	147	84.76 (8.03)	85 (68-98)	-.51	-.85
Vocabulary breadth	147	90.52 (5.91)	92.50 (77-100)	-.54	-.80
Passage comprehension	147	86.84 (7.87)	89.47 (63-100)	-1.25	1.52
Sentence comprehension – accuracy	52	.05 (.13)	.05 (-.20-.35)	.64	.17
Sentence comprehension – reading time at main verb	52	-35.85 (98.20)	-25.00 (-379.10-545.60)	-1.22	.43
Online sentence production	147	.43 (.26)	.45 (-.05-.95)	-.12	.70
Sentence production - recalling sentences	147	11.46 (2.38)	12.00 (8-18)	.55	.08

Note: s.d. = Standard Deviation

4.3.3.1 Correlational Analysis of the Language Use Measures

As shown in Table 4.20, the two vocabulary measures are highly correlated. Passage comprehension was moderately to strongly correlated with the vocabulary measures, and with the second sentence production measure of recalling sentences. The recalling sentences production measure was weakly to moderately correlated with both vocabulary measures, and the online sentence production measure was weakly correlated with both vocabulary measures. The sentence comprehension measures were not significantly correlated with other measures.

Table 4.20
Inter-item Correlations of Language Use Measures

	1.	2.	3.	4.	5.	6.	7.
1. Vocabulary depth							
2. Vocabulary breadth	**.54****						
3. Passage comprehension	**.63****	**.39****					
4. Sentence comprehension – accuracy	-.02	-.16	-.07				
5. Sentence comprehension – reading time at main verb	-.17	.03	-.03	.18			
6. Online sentence production	**.17***	**.19***	.11	.15	.12		
7. Sentence production - recalling sentences	**.31****	**.19***	**.33****	-.08	.09	.10	

*Note: *p<.05; **p<.01*

4.3.4 Regression Analyses of SES, Language Exposure and Language Use measures

In the following sections, key relationships between the constructs will be explored to address the main research questions. Multiple regression analyses will be used to examine (1) the relationship between SES and language exposure, (2) the relationship between SES and language use, and (3) the relationship between language exposure and language use.

4.3.3.1 Relationship Between SES and Language Exposure Measures

Multiple linear regressions were run to assess the extent to which SES predicts different aspects of language exposure. In these analyses, the two SES factors identified in the factor analysis were used as predictors for each of the five factors identified in the factor analysis of the language exposure measures, and ART.

Overall, neither of the SES factors were found to substantially predict most of the measures of language exposure (Table 4.21). A significant model was only found for *Information Exposure*, with subjective SES as a significant predictor. The model explained 5% of the variability in language exposure. SES did not significantly predict *recreational reading*, *social media use*, *reading for academic purposes*, or *spoken language*. A marginal positive relationship was found between objective SES and ART (p=.06). Overall, these findings show only a small influence of SES in written or spoken language exposure in a young adult sample, that is mainly focused on *Information Exposure*. Interestingly, the regression coefficient is negative suggesting greater information exposure for participants who reported lower SES on the subjective SES measure.

As SES was not strongly related to language exposure, a mediation analysis examining whether language exposure mediated the relationship between SES and language processing was not performed.

Table 4.21
Linear Regression Analysis of SES Predicting Language Exposure

Predictors	*B*	*SE B*	*β*	*t*	*p*
Outcome: Recreational Reading **Overall model:** R^2 = .02; F(2,142) = 1.36, *p*=.26					
Constant	.003	.08			
Subjective SES	-.05	.11	-.05	-.49	.63
Objective SES	.20	.12	.15	1.64	.10
Outcome: Social Media Use **Overall model:** R^2 = .01; F(2,142) = .95, *p*=.39					
Constant	.03	.08			
Subjective SES	.04	.11	.03	.36	.72
Objective SES	-.16	.12	-.12	-1.36	.18
Outcome: Reading for Academic Purposes **Overall model:** R^2 = .01; F(2,142) = .56, *p*=.57					
Constant	.01	.08			
Subjective SES	-.10	.11	-.08	-.82	.41
Objective SES	-.03	.12	-.03	-.28	.78
Outcome: Information Exposure **Overall model:** R^2 = .05; F(2,142) = 3.49, *p*=.03					
Constant	.01	.08			
Subjective SES	-.28	.11	-.24	-2.63	.01
Objective SES	.16	.12	.12	1.35	.18
Outcome: Spoken Language **Overall model:** R^2 = .01; F(2,142) = .82, *p*=.44					
Constant	-.002	.08			
Subjective SES	.14	.11	.12	1.26	.21
Objective SES	-.03	.12	-.03	-.28	.78
Outcome: ART **Overall model:** R^2 = .02; F(2,142) = 1.77, *p*=.17					
Constant	11.27	.51			
Subjective SES	-.35	.67	-.05	-.52	.60
Objective SES	1.38	.74	.17	1.86	.06

Note: SES = socioeconomic status; ART = Author Recognition Test

4.3.3.2 Relationship between SES and Language Use

To investigate whether there is a relationship between SES and language use in this sample, several multiple linear regressions were conducted. Language use measures were divided into (1) vocabulary measures, (2) comprehension measures, including passage and sentence comprehension and (3) production measures. For vocabulary, corrected percent score on the LexTALE lexical decision task was used as a measure of vocabulary breadth, and percent correct score on the Nelson-Denny synonyms task as a measure of vocabulary depth. For comprehension, percent correct score on the Nelson Denny comprehension task was used as a measure of passage comprehension, and difference score for accuracy (SRC and ORC) for the sentence comprehension question and difference in reading time at the main verb (SRC and ORC) were used as measures of sentence comprehension. Lastly, for production, proportion difference of relative clauses produced (PRC and ORC) was used as a measure of online sentence production, and standard scores from the CELF-5 recalling sentences subtest was used as a second measure of production.

A significant model was only found for vocabulary depth, with both subjective SES and objective SES as significant predictors (Table 4.22). The model explained 8% of the variability in vocabulary depth. A marginally significant model ($p = .09$) was also found for passage comprehension, with objective SES as a significant predictor (Table 4.22). SES did not significantly predict vocabulary breadth, sentence comprehension, or either measure of sentence production.

Table 4.22
Linear Regression Analyses of SES Predicting Vocabulary Knowledge, Language Comprehension and Language Production

Predictors	*B*	*SE B*	*β*	*t*	*p*
Outcome: Vocabulary depth **Overall model:** R^2 = .08; F(2,139) = 6.32 , *p*=.002					
Constant	79.28	1.03			
Subjective SES	-2.74	.135	-.18	-2.04	.04
Objective SES	5.20	1.49	.31	3.49	.001
Outcome: Vocabulary breadth **Overall model:** R^2 = .01; F(2,141) = .64, *p*=.53					
Constant	87.75	.62			
Subjective SES	-.66	.82	-.07	-.81	.42
Objective SES	.58	.91	.06	.64	.52
Outcome: Passage comprehension **Overall model:** R^2 = .03; F(2,142) = 2.42, *p*=.09					
Constant	80.70	1.15			
Subjective SES	-1.26	1.51	-.08	-.84	.41
Objective SES	3.67	.167	.20	2.20	.03
Outcome: Sentence comprehension – accuracy **Overall model:** R^2 = .03; F(2,49) = .74, *p*=.48					
Constant	.06	.02			
Subjective SES	.001	.03	.003	.02	.99
Objective SES	-.03	.03	-.17	-1.10	.28
Outcome: Sentence comprehension – reading time at main verb **Overall model:** R^2 = .02; F(2,49) = .30, *p*=.74					
Constant	-36.00	15.29			
Subjective SES	17.93	23.22	.14	.77	.45
Objective SES	-11.49	27.99	-.07	-.41	.68
Outcome: Online sentence production **Overall model:** R^2 = .01; F(2,142) = .36, *p*=.70					
Constant	.39	.02			
Subjective SES	.01	.03	.03	.29	.77
Objective SES	-.03	.04	-.08	-.85	.40
Outcome: Recalling sentences **Overall model:** R^2 = .01; F(2,142) = .74, *p*=.48					
Constant	10.35	.22			
Subjective SES	.04	.29	.01	.14	.88
Objective SES	.33	.32	.10	1.04	.30

Note: SES = socioeconomic status

4.3.3.3 Relationship Between Language Exposure and Language Use

In this section, the relationships between measures of written and spoken language exposure and measures of language use will be examined. In each analysis, separate regressions were run for each of the language use outcomes, grouped as vocabulary knowledge, language comprehension and language production. In all analyses, a hierarchical multiple regression was run where the control variables were entered first (working memory and non-verbal IQ).

4.3.3.3.1 Relationship Between Language Exposure and Vocabulary Knowledge

Several multiple linear regressions were run to predict vocabulary knowledge based on the factors of language exposure and ART, with the outcome variables of vocabulary depth (as measured by percent correct on the Nelson-Denny vocabulary test) and vocabulary breadth (as measured by the corrected percent score on the LexTALE vocabulary test).

Significant models were found when predicting both vocabulary depth and breadth, as shown in Table 4.23. Exposure factors predicted a total of 39% of variance in vocabulary depth and 17% of vocabulary breadth. *Recreational reading*, *social media use*, *spoken language*, and the ART were significant predictors of vocabulary depth, after the control measures were taken into account. *Recreational reading* and ART had a positive relationship with vocabulary depth, whereas *social media use* and *spoken language* showed a negative relationship. Vocabulary breadth was significantly predicted by ART and *social media use*, and marginally by *spoken language*. As for vocabulary breadth, ART had a positive, and *social media use* and *spoken language* a negative relationship with vocabulary breadth.

Table 4.23
Linear Regression Analysis of Language Exposure Predicting Vocabulary Knowledge

Predictors	*B*	*SE B*	*β*	*t*	*p*
Outcome: Vocabulary depth **Overall model:** $R^2 = .45$					
Step 1					
Constant	64.63	5.29			
Working memory	.77	.44	.15	1.74	.08
Non-verbal IQ	.74	.47	.14	1.58	.12
Step 2					
Recreational Reading	2.50	.93	.20	2.69	.01
Social Media Use	-2.32	.81	-.18	-2.85	.01
Reading for Academic Purposes	1.15	.84	.09	1.36	.18
Information exposure	-.32	.90	-.03	-.35	.73
Spoken Language	-2.16	.82	-.17	-2.65	.01
ART	.97	.17	.47	5.68	<.001
$\Delta R^2 = .39$; $F(8,135) = 13.62$, $p<.001$					
Outcome: Vocabulary breadth **Overall model:** $R^2 = .23$					
Step 1					
Constant	79.17	3.09			
Working memory	.43	.26	.14	1.63	.11
Non-verbal IQ	.46	.27	.15	1.69	.09
Step 2					
Recreational Reading	.75	.64	.10	1.17	.24
Social Media Use	-1.29	.56	-.17	-2.29	.02
Reading for Academic Purposes	.63	.57	.09	1.10	.27
Information exposure	-.93	.63	-.13	-1.49	.14
Spoken Language	-1.06	.56	-.14	-1.89	.06
ART	.38	.12	.31	3.19	.002
$\Delta R^2 = .17$; $F(8,137) = 5.06$, $p<.001$					

Note: ART = Author Recognition Test

4.3.3.3.2 Relationship Between Language Exposure and Language Comprehension

Three multiple linear regressions were run to predict language comprehension at the sentence and passage levels, based on the language exposure factors and ART. The outcome variables were passage comprehension (as measured by percent correct

scores on the Nelson-Denny passage comprehension task), and sentence comprehension (as measured by the proportion difference for accuracy scores and difference in reading time at the main verb in the sentence comprehension task). Due to the error with the online sentence comprehension task, the sample size for the regressions analysing accuracy and reading time at main verb was 52 participants. The whole sample was used for passage comprehension (*N*=147).

Reading rate, working memory and non-verbal IQ were entered in the first step of each model as control variables. As shown in Table 4.24, a significant model was found when predicting passage reading, with exposure factors predicting a total of 9% of the variance, after the control variables were taken into account (working memory and non-verbal IQ also significantly predicted the outcome in this analysis). *Reading for academic purposes* was the only significant predictor in this analysis. No significant models were found for sentence comprehension. *Spoken language* had a significant negative relationship with sentence comprehension accuracy and *recreational reading* was a marginally significant predictor of sentence comprehension reading time.

Table 4.24
Linear Regression Analysis of Language Exposure Predicting Language Comprehension

Predictors	*B*	*SE B*	*β*	*t*	*p*
Outcome: Passage comprehension					
Overall model: $R^2 = .27$					
Step 1					
Constant	45.69	6.58			
Working memory	1.13	.45	.20	2.51	.01
Non-verbal IQ	1.65	.47	.28	3.49	.001
Reading rate	.03	.01	.15	1.99	.05
Step 2					
Recreational Reading	1.24	1.17	.09	1.06	.29
Social Media Use	-.39	1.02	-.03	-.38	.70
Reading for Academic Purposes	2.52	1.06	.18	2.43	.02
Information exposure	.33	1.13	.02	.29	.77
Spoken Language	-1.29	1.02	-.09	-1.27	.21
ART	.36	.22	.16	1.66	.10
$\Delta R^2 = .09$; $F(9,137) = 5.70$, $p<.001$					
Outcome: Sentence comprehension – accuracy					
Overall model: $R^2 = .28$					
Step 1					
Constant	.14	.12			
Working memory	.01	.01	.22	1.36	.18
Non-verbal IQ	-.01	.01	-.12	-.78	.44
Reading rate	<.001	<.001	-.20	-1.35	.18
Step 2					
Recreational Reading	-.03	.02	-.19	-1.22	.23
Social Media Use	-.004	.02	-.03	-.23	.82
Reading for Academic Purposes	.001	.02	.01	.06	.96
Information exposure	-.002	.02	-.02	-.12	.91
Spoken Language	.05	.02	.41	-3.00	.01
ART	.002	.004	.11	.61	.55
$\Delta R^2 = .22$; $F(9,42) = 1.78$, $p=.10$					
Outcome: Sentence comprehension – reading time at main verb					
Overall model: $R^2 = .17$					
Step 1					
Constant	-4.88	103.44			
Working memory	4.39	5.67	.14	.78	.44
Non-verbal IQ	-4.53	8.59	-.10	-.53	.60
Reading rate	-.09	.19	-.08	-.46	.65
Step 2					
Recreational Reading	39.00	19.73	.39	1.98	.06
Social Media Use	-1.66	15.18	-.02	-.11	.91
Reading for Academic Purposes	-3.76	19.86	-.04	-.19	.85
Information exposure	-1.67	17.50	-.02	-.10	.93
Spoken Language	.66	17.04	.01	.04	.97
ART	-1.53	3.45	-.09	-.44	.66
$\Delta R^2 = .15$; $F(9,42) = .71$, $p=.69$					

Note: ART = Author Recognition Test

4.3.3.3.3 Relationship Between Language Exposure and Sentence Production

Two multiple linear regressions were run to predict sentence production based on the factors of language exposure and ART, with the outcome variables of online sentence production (as measured by the proportion difference of relative clauses produced) and recalling sentences (as measured by scaled scores on the CELF-5 recalling sentences subtest). Working memory and non-verbal IQ were entered in the first step as control variables.

A significant model was found for recalling sentences, but not for online sentence production. Online sentence production was not predicted by any of the language exposure measures. Recalling sentences was significantly predicted by working memory, and marginally (p = .06) by ART.

Table 4.25
Linear Regression Analysis of Language Exposure Predicting Language Production

Predictors	*B*	*SE B*	*β*	*t*	*p*
Outcome: Online sentence production **Overall model:** $R^2 = .06$					
Step 1					
Constant	.34	.12			
Working memory	-.01	.01	-.08	-.90	.37
Non-verbal IQ	.01	.01	.12	1.32	.19
Step 2					
Recreational Reading	.02	.03	.08	.81	.42
Social Media Use	-.03	.02	-.11	-1.31	.19
Reading for Academic Purposes	.04	.03	.14	1.61	.11
Information exposure	.004	.03	.04	.15	.88
Spoken Language	-.02	.02	-.08	-.92	.36
ART	-.01	.01	-.10	.93	.36
$\Delta R^2 = .04$; $F(8,138) = 1.02$, $p=.43$					
Outcome: Recalling sentences **Overall model:** $R^2 = .18$					
Step 1					
Constant	6.79	1.04			
Working memory	.36	.09	.34	4.16	<.001
Non-verbal IQ	.01	.09	.01	.15	.88
Step 2					
Recreational Reading	.17	.23	.07	.75	.46
Social Media Use	-.09	.20	-.03	-.43	.67
Reading for Academic Purposes	.07	.21	.03	.34	.73
Information exposure	-.07	.22	-.03	-.33	.74
Spoken Language	.23	.20	.09	1.15	.25
ART	.08	.04	.19	1.88	.06
$\Delta R^2 = .06$; $F(8,138) = 3.71$, $p=.001$					

Note: ART = Author Recognition Test

4.4 Discussion

This study assessed the relationship between the constructs of SES, written and spoken language exposure, and language use in a sample of young adults. Three research questions were addressed (1) the relationship between SES and language

exposure, (2) the relationship between SES and language use, and (3) the relationship between language exposure and language use. To assess these questions, several adaptations were made to the indicators of all three constructs. For SES, in addition to the standard objective measures of SES used in Study 1, a subjective SES measure was added. For language exposure, the same measures of Reading Habits, Reading Time, Comparative Reading Habits, and ART were used as in Study 1, and a new comparative measure of spoken language exposure was developed. For language use, as a result of a systematised literature review, two new vocabulary measures were used, one assessing vocabulary depth and one measuring vocabulary breadth. In addition to vocabulary, broader language comprehension was measured using an online sentence comprehension task and a passage comprehension task, and language production was measured using an online sentence production task and a standardised recalling sentences task.

The analyses of the SES measures showed that SES was captured by two distinct factors, one with loadings of objective measures of SES (parental education, parental occupation, and household income), and one with loadings of subjective measures of SES. The subjective measures included participants' self-reports of where themselves and their families stood on a societal hierarchy at three different time points (0-5 years of age, 5-18 years of age, and now). Importantly, the analyses of SES showed that the recruited sample covered a whole range of SES backgrounds, as in Study 1.

The analyses of the language exposure measures demonstrated that they are underpinned by five different factors of exposure. The first four factors identified had a similar factor structure as in Study 1. The factors included *recreational reading, social media use, reading for academic purposes, information exposure*. Additionally, a fifth *spoken language* factor was found. The results of Study 1 did not find a distinct spoken

language exposure factor, but by creating a new measure of comparative spoken language, Study 2 results found a fifth factor representing spoken language.

The relationships between measures of SES and language exposure and language use in the current young adult sample can be summarized as follows. When investigating the relationship between SES and language exposure, results showed SES significantly predicted *information exposure*, with the subjective SES factor as a significant predictor. Additionally, a marginal positive relationship was found between objective SES and the ART. However, SES did not significantly predict *recreational reading*, *social media use*, *reading for academic purposes*, or *spoken language*.

Secondly, looking at the relationship between SES and language use, the results showed that SES predicted vocabulary depth, with both objective and subjective SES as predictors, but did not predict other measures of language use. The result that SES has an influence on vocabulary knowledge has been found in previous studies involving children (e.g. Hoff, 2003; Rowe, 2012; Weisleder & Fernald, 2013). The results of the current study therefore show that the relationship between SES and vocabulary continues beyond childhood. The relationship between SES and vocabulary in child language has often been attributed to the differences in language exposure in different SES groups. Thus the relationship between written and spoken exposure and a series of measures of language use was examined in the current study.

When investigating the relationship between language exposure and language use, clear and strong relationships were found between both written and spoken language exposure and vocabulary knowledge. The measures of exposure explained a total 39% of variance in vocabulary depth, and 17% in vocabulary breadth. The ART and *recreational reading* factor were significant positive predictors of vocabulary

depth, and the ART also explained a significant proportion of variance in vocabulary breadth. *Social media use* and *spoken language* were both significant negative predictors of both vocabulary measures. This suggests that individuals who spend more time on social media and in spoken language contexts, have lower vocabulary knowledge than those who spend less time on social media and in spoken language contexts. Spoken language has been found to contain less complex words and syntactic structures than written language (Roland, Dick, & Elman, 2007), which may explain this negative relationship.

Weaker relationships were found between measures of language exposure and other language use outcomes. Reading for academic purposes explained variance in passage comprehension, and the *Recreational Reading* factor showed a marginally significant relationship with sentence comprehension. When predicting sentence production using the standardised recalling sentences task, the ART was also a marginally significant predictor in a model that also included working memory as a significant predictor. The study by Montag and MacDonald (2015), from which the online sentence production task was taken, showed a small but significant effect of ART in online sentence production in their sample of young adults, which is unlike what was found in the current study. Given that previous research has also showed similar positive relationships between ART and sentence comprehension and production (e.g. Montag & MacDonald, 2015), the findings show that ART could be related to sentence processing in young adults, and therefore this marginal predictor should be considered.

In addition to assessing the main research questions, this study was able to replicate two previous studies examining sentence comprehension and sentence production (Montag & MacDonald, 2015; Wells et al., 2009). When replicating the Wells et al. (2009) study, results showed a significant effect of relative clause type and

region both in accuracy and reading times. As in the original study, individuals' reading time for ORCs was significantly slower than for SRCs at the key region 3 which is the location of the main verb. The main verb is a key aspect of the sentence as it immediately follows the relative clause, and it is the key region for the integration of information between the main clause and the relative clause. Although this study did replicate a significant interaction of relative clause type x region, longer reading times were also found at region 2 in ORCs compared to SRCs. This could suggest that individuals were anticipating a need for reanalysis of the noun assignments and resolving the ambiguity early. Wells et al. (2009) suggest that differences may occur in region 2 due to different word types in this region for SRCs and ORCs. In SRCs, region 2 contains the second noun, whereas in ORCs, region 2 contains the embedded verb. Therefore, this difference in word type, may create differences in spill-over effects into the next region for the different sentence types, which may increase the difference in reading time at region 3.

The current study also replicated Montag and MacDonald's (e.g. 2015) study examining animacy effects in the production of complex sentences. This study replicated the effect of animacy of the target noun on structure choice: individuals produced more PRCs compared to (active) ORCs when describing an animate target. Additionally, individuals produced be-passives more than get-passives when describing an animate target. However, this study did not replicate the result that text exposure, as measured by the ART, predicts structure choice.

It must be noted that post-hoc power analysis was not performed on this data. Some recent papers have suggested that post-hoc power analysis to assess non-significant results can be misleading and advise against it (e.g. Hoenig & Heisey, 2001, Levine & Ensom, 2001, Zhang et al., 2019), therefore it was not included here.

In order to evaluate the findings from this study, there are several methodological limitations that must be considered. The results of Study 1 showed few significant relationships between SES and language exposure when using an objective measure of SES. Using an objective measure of family SES could be problematic when investigating SES in a young adult university population, as this is a transitional period during which they have most likely moved out of the parental home and are furthering their education. Therefore, parental education, parental occupation and income may not directly relate to their circumstances as much as it would as a child. In Study 2, SES was also assessed using the MacArthur SSS (Adler et al., 2000). This allowed the individual to subjectively place themselves and their family on a societal hierarchy based on income, education, and occupation, but did not depend on the individual correctly reporting information on parental SES. Using this measure, SES predicted vocabulary knowledge, but did not significantly predict other aspects of language use, or language exposure in this sample. This could suggest first, that SES does not influence exposure to language in young adults, and second, that it has a more limited role in language use that is specifically focussed on vocabulary. However, it is also possible that this result could be due to the difficulty of assessing SES in a transitional population that might be less strongly influenced by parental SES, and who have not yet finished education, and do not have a stable occupation or income.

Secondly, it is possible that the measures of sentence comprehension and sentence production measures may not be sensitive enough to capture individual differences in language, as they are designed to uncover universal processes of language. Successful replications of the comprehension and production studies showed that these are reliable measure of those universal of language processing. James et al. (2018) also found a lack of correlations concerning individual differences using a self-

paced reading task and suggested that it is not because of the reliability of the measure as a measure of language, but due to the measure failing to capture individual differences. Therefore, there may be relationships between these variables that may not have been captured using these particular measures.

In conclusion, the results of Study 2 show that the influence of SES on language exposure and language use may be reduced when an individual reaches adulthood. The results also show that language exposure, and in particular recreational and fiction book reading, relates to language use in young adults, but it is mainly focused on vocabulary. This supports previous research that has shown this relationship (e.g. Acheson et al., 2008; Stanovich & West, 1989; Torppa et al., 2020).

Chapter 5: General Discussion

The aim of the research presented in this thesis was to investigate how socio-economic status (SES) and cumulative differences in language exposure relate to skills supporting language processing, particularly those relevant for sentence comprehension and production in young adults. Previous research has mostly focused on the role of SES in vocabulary and grammar development, but not in more complex skills, such as sentence processing. Additionally, the majority of previous research has focused on SES and language input and exposure in early childhood and through the development of literacy. Thus, the goal of the present research was to fill this gap by assessing this relationship beyond childhood, in a sample of young adults, and concerning more complex language skills. A second goal of this research was to develop a comprehensive set of measures assessing written and spoken language exposure, and to relate them to different measures of language use.

5.1 Summary of Key Findings

The main aim of Study 1 was to investigate associations between SES, language exposure and offline language skills, measured using standardised tests of vocabulary and grammar, in a sample of young adults. Study 1 used a newly developed questionnaire which was created by building upon previous measures used to assess different aspects of SES and language exposure. Creating a comprehensive set of language exposure measures allows young adults' cumulative language exposure to be investigated.

SES was assessed using measures of parental education, parental occupation (Elias & Birch, 2010), and household income. Language exposure was assessed using

measures adapted from previous research, including previously used, reliable measures of reading habits, and newly developed measures, such as measures of spoken language exposure and sentence structure familiarity.

The first measure assessed Reading Habits, including number of books an individual reads in a year, frequency of bookstore visits and number of books in the home (Hamilton, Hayiou-Thomas, Hulme, & Snowling, 2016; Stanovich & West, 1989). Second, a Reading Time measure, adapted from Acheson et al. (2008), asked about time spent reading different types of material including textbooks, fiction books, newspapers, e-mail, and reading content on social media. The third measure assessed Comparative Reading Habits (CRH) of different types of materials, based on the measure created by Acheson et al. (2008). This asked about individuals' reading habits compared to peers, including academic material, fiction, newspapers and magazines, as well as complexity of reading material and enjoyment of reading. Finally, An updated version of the Author Recognition Test was included as an additional measure of print exposure (ART, Stanovich & West, 1989). This was updated based on suggestions given in Moore and Gordon (2015).

In addition to assessing written language exposure, a measure of spoken language exposure was developed, adapted from the LEAP-Q (Marian, Blumenfeld, & Kaushanskaya, 2007), which asked participants to indicate how much time they spend listening to and communicating using spoken language. This included talking with friends and family, watching TV, watching online video clips, internet media (such as online forums), online messaging, texting, and listening to music with lyrics.

Finally, two tasks were developed to attempt to measure individual differences in exposure to less frequent grammatical structures. These tasks asked participants to rate how often they encounter different grammatical structures. Examples of each

structure were presented in the task either individually or with other sentences that are structurally different but have the same meaning. For example, a sentence containing an object relative clause, e.g. *The pasta that the chef cooked was very tasty* has the same meaning as a sentence containing a passive relative clause, e.g. *The pasta that was cooked by the chef was very tasty*. Therefore, keeping the meaning of the sentences the same ensures that a difference in familiarity is due to the difference in the structure (subject-first versus object-first) rather than a difference in the meaning.

These measures were used alongside standardised tests of offline language processing, including receptive and expressive grammar, and vocabulary knowledge, to investigate the relationships among the constructs of interest.

In Study 1, the results of the SES measures showed that although a university sample was recruited, this sample included participants from a wide range of SES backgrounds (as shown in Appendix 3). Correlational analysis showed that the indicators of SES were weakly intercorrelated, and a composite SES measure was created.

The results of the language exposure measures showed that items within each measure were weak to moderately intercorrelated. Additionally, the correlations between the measures of exposure were sensible. Items tapping book reading were moderately correlated, such as CRH fiction and CRH enjoyment of reading correlated highly with time spent reading fiction. Items measuring academic reading were significantly correlated, such as CRH academic material and Reading Time estimates of textbooks and academic material significantly correlating with one another. Alternatively, book reading and academic measures did not significantly correlate showing a dissociation between these types of reading. The ART correlated with other

written language exposure items, such as number of books in the home, frequency of bookstore visits, comparative enjoyment of reading, and reading time of fiction books. Finally, no significant correlations were found between the measures of written and spoken language exposure, with the exception of CRH reading content on social media and the spoken language items.

The language exposure items were factor analysed which found that these measures are underpinned by five distinct factors of exposure. The factors included *recreational reading*, including items such as books read, time spent reading fiction, and frequency of bookstore visits, *communication and social media use*, including time spent on social media and online messaging, *reading for academic purposes*, which included reading textbooks and academic material, *information exposure*, which included time spent reading newspapers and email, and *accessibility of reading material*, including the ART, and books in the home.

The results of Study 1 showed no significant relationship between SES and language exposure or language use. There was a small positive relationship found between maternal education and expressive grammar. This could suggest that SES may no longer be an important influence on language in a population of young adults attending university, and the effects of childhood SES may be diminished by adulthood.

Some significant relationships were found between some aspects of language exposure and language use. Vocabulary knowledge was weakly negatively correlated with the *Communication and Social Media Use* factor, which showed that individuals that spend more time on social media and in spoken language contexts, have lower vocabulary knowledge than those that spend less time on social media and in spoken

language contexts. Additionally, receptive and expressive grammar significantly related to familiarity of active and ORC structures.

When investigating the newly developed sentence structure familiarity rating tasks, correlational analyses showed familiarity of ORCs correlated with the *Communication and Social Media Use* factor, which includes some spoken language exposure items, and negatively correlated with the *Information Exposure* factor. Additionally, a small positive relationship between the *Accessibility to Reading Materials* factor, with ART loading onto this factor, and familiarity of passive sentences was found. These relationships follow the results of corpus data that show a relatively higher frequency of ORCs in spoken language, and of passive structures in written language (Roland et al., 2007).

Study 2 aimed to build on the results from Study 1 by including an additional subjective measure of SES, and further adapting the language exposure measures. In addition, a broader set of language use measures were included to measure vocabulary breadth and depth, sentence comprehension, passage comprehension, and sentence production. This allowed investigation of SES and language exposure and the relationship with language processing, including online sentence comprehension and production.

As the results of Study 1 showed a lack of relationships between SES and measure of language exposure and language processing, Study 2 also included a subjective measure using the MacArthur Scale of Subjective Social Status in addition to the objective measures of parental education, occupation, and income. This measure asked participants to indicate where they position themselves on a societal hierarchy at three different time points: (1) at this point in time, (2) 0-5 years old, and (3) 5-18 years

old. As well as the addition of the subjective SES measure, the spoken language exposure measure was changed to assess spoken language comparatively, as in the Comparative Reading Habits measure assessing written language exposure. The comparative spoken language exposure measure asked participants to report time spent in a range of spoken language contexts compared to their peers.

A systematised review was conducted to examine studies that have used one or more vocabulary measures along with measures of language exposure in a young adult sample, and examine the relationships found. The results found that using a range of vocabulary knowledge test formats, including assessing knowledge of synonyms and antonyms, defining words orally or through a multiple-choice format, and receptive vocabulary picture tasks, vocabulary significantly correlated with measures of print exposure, including medium to high correlations with the ART, in all but one study. The results of the systematised review influenced the choice of vocabulary test used in Study 2, which included a measure of vocabulary breadth and depth.

As in Study 1, correlations showed similar, sensible patterns of relationships between items. A factor analysis was again conducted on the exposure items which created five factors: *recreational reading*, *social media use*, *reading for academic purposes*, *information exposure*, and additionally, a fifth spoken language exposure factor. Factor 5 had loadings of time spent talking with family, watching TV shows/films, and texting. The results of Study 1 did not find a distinct spoken language exposure factor, but by creating a new measure of comparative spoken language, Study 2 results found a fifth factor representing spoken language.

In order to analyse the SES measures, the indicators were factor analysed. This produced two distinct factors: factor 1 represented subjective SES due to loadings of

the subjective measures of SES, factor 2 represented objective SES due to loadings of the objective measures (parental education, parental occupation, and household income). In contrast with Study 1, some relationships were found with SES and other variables in Study 2.

Regression analyses were run between SES, language exposure and language processing measures. When looking at the relationship between SES and language use, SES significantly predicted vocabulary depth, with both objective and subjective SES measures as predictors. SES also related to some aspects of language exposure. SES predicted *Information Exposure*, with subjective SES as a significant predictor. As SES was not strongly related to language exposure, a mediation analysis examining whether language exposure mediated the relationship between SES and language processing was not performed.

Language exposure significantly predicted vocabulary depth and breadth, after working memory and non-verbal IQ were controlled for. The ART and *recreational reading* factor were significant positive predictors of vocabulary depth, and the ART also explained a significant proportion of variance in vocabulary breadth. The suggests that it is specifically book reading exposure that relates to vocabulary knowledge. Negative relationships were found with the *social media use* and *spoken language* factors when predicting both vocabulary depth and breadth. Spoken language has been found to contain less complex words and syntactic structures than written language (Roland, Dick, & Elman, 2007), which may explain this negative relationship.

Additionally, when reading rate was also controlled for, language exposure predicted variance in passage comprehension. The *recreational reading* factor also showed a marginally significant relationship with sentence comprehension. This result

suggests that the more an individual reads for pleasure, the better able they are to comprehend complex sentences. When predicting sentence production, the ART was a marginally significant predictor, showing that reading for pleasure also relates to ability to produce complex sentences.

Study 2 also allowed a replication analysis of two previous studies that have used the sentence comprehension and sentence production measures in a similar sample. These measures investigated processing of relative clauses, both in comprehending and producing them. Using a sentence comprehension task, Study 2 replicated the results of Wells et al. (2009) in that there was a significant difference in both relative clause reading time and reading time at the main verb between SRCs and ORCs. Reading time for ORCs was significantly slower overall and at the main verb compared to SRCs. There was also a significant difference in accuracy rates for SRCs in comparison with ORCs: comprehension questions were answered accurately more often after reading SRCs than ORCs, therefore replicating the results found in previous studies (e.g. Wells et al., 2009).

When investigating production of relative clauses, Study 2 replicated the results found in Montag & MacDonald (2015). Individuals used more PRCs than ORCs in response to animate targets, and additionally used significantly more be-passives compared to get-passives, which supports the results of Montag & MacDonald's study (2015). However, language exposure did not predict production choice, as found in Montag & MacDonald's study (2015).

Taken together, these findings contribute to the research into how SES and language exposure relate to complex language use in young adults. The theoretical implications of these results are discussed below.

5.2 Implications

Overall, the findings from Study 2 show relationships between written language exposure, specifically recreational reading and fiction book reading, clearly relating to vocabulary knowledge. Previous research consistently points to significant positive relationships between recreational reading and reading skills (see Mol & Bus, 2011, for review). The research by Torppa et al. (2020) found that in younger childhood, poorer passage comprehension predicted less reading for pleasure. Whereas in later childhood and adolescence, this relationship was flipped, in that more reading for pleasure predicted better passage comprehension. This suggests that in early childhood, reading for pleasure is predicted by competence in reading, whereas in later childhood, reading for pleasure helps improve language comprehension. In the present research, language exposure predicted passage comprehension, and specifically the ART and *Recreational Reading* were significant predictors. Additionally, the *Recreational Reading* factor showed a marginally significant relationship with sentence comprehension. This supports the results found in Torppa et al. (2020) adding to the previous literature of the relationship between written language exposure and language skills and extends this relationship to young adults. Torppa et al. (2020) also found that digital reading (for example email and Facebook) negatively related to comprehension. The present study (Study 2) showed the *Social Media* factor, which included time spent instant messaging and on social media (including Facebook), showed negative relationships with passage and sentence comprehension, although this relationship was not significant. These results could help inform practice to encourage recreational reading in young adults by showing the importance of recreational reading in relation to an individual's reading skills, particularly for vocabulary and comprehension skills.

The current research extends the previous literature to focus on complex sentence structures. Marginal relationships were found when investigating correlations between written language exposure and sentence comprehension and production of relative clauses. Corpus studies have found that written language contains more complex words and syntactic structures than spoken language (Roland et al. 2007). As the measures of sentence comprehension and production examined language processing of complex sentence structures, such as PRCs and ORCs, this could explain the relationship between these tasks and written language exposure. Therefore, further research is encouraged to explore this relationship further.

Another aspect of this research that goes beyond previous literature is the investigation of the relationship between SES and language processing in young adults. Previous literature has focused on this relationship in children and has shown SES to relate to vocabulary knowledge and grammar (e.g. Fernald, Marchman, & Weisleder, 2013; Hart & Risley, 1999; Hoff, 2003; Rowe & Goldin-Meadow, 2009). For example, Hart and Risley (2003) showed large differences in child-directed speech between LSES and HSES families. Rowe (2008) found that children's vocabulary was predicted by child-directed speech in the home, which differed between SES groups. Additionally, Weisleder and Fernald (2013) showed SES was related to real-time language processing in children. The results of the present research showed that SES significantly predicted vocabulary knowledge in young adults, as found in Study 2, but did not relate to more complex language such as sentence comprehension and production. This could suggest that SES is still important for vocabulary knowledge in adulthood, but the difference in more complex language processing, such as sentence processing, may be reduced by education. In summary, the analyses reported provide a positive message of a possible diminishing effect of SES, which could be due to

education, on language use beyond childhood. Although it must be noted that these studies are relational and cannot infer causality.

Finally, a key theory within the language learning literature is statistical learning. According to this theory, an individual has the ability to implicitly learn the regularities within a language system, and the statistical probabilities of one syllable occurring after another, or one word occurring after another in a sentence. This study, therefore, supports the statistical learning theory in terms of vocabulary, as a significant relationship was found between written and spoken language exposure and vocabulary knowledge. However, no significant relationship was found between language exposure and sentence comprehension and production. Therefore, this study did not support the statistical learning theory in terms of learning sentences through exposure.

5.3 Measurement Issues

5.3.1 SES

Measuring SES in children requires information about parental SES, whereas measuring SES in adults requires information about their own education, occupation, and income. In young adults, such as university students, it is more difficult to assess SES, compared to children and adults. Many university students leave the family home and therefore, parental education, parental occupation and income may not directly relate to their circumstances as much as it would as a child. However, they do not yet have a stable income, occupation, or education, as they are continuing further study. This transitional period makes it difficult to categorise young adults when assessing SES. In order to attempt to reliably capture SES in this sample, both objective and subjective measures were used in Study 2. The analyses showed the subjective measure

to relate to the other variables more than the objective measure. However, from the factor analysis that was performed to group the SES variables, it was clear that participants may be relying on household income to subjectively measure their SES compared to other people in society, due to the income measure loading onto the subjective factor of SES. An alternative way to measure SES in young adults more objectively may be through using a multilevel approach, which combines compositional measures, such as income and education, and contextual measures, such as neighbourhood and geographic area (Shavers, 2007).

5.3.2 Language Exposure

This research was rigorous in assessing as much of an individual's cumulative language exposure as possible by including multiple different measures. Two measures were developed specifically for this study to capture spoken language exposure and sentence structure familiarity (as an indirect measure of exposure). The spoken language exposure measure was created for Study 1 as there was no previous measure found in the literature. The measure that was created used time estimates which asked participants how much time they spend listening to and communicating using spoken language. There was a lack of results found with this measure in Study 1. Therefore, the spoken language exposure measure was adapted in Study 2 to ask participants about their spoken language exposure in a comparative way, similar to the comparative reading habits measure.

The results of Study 2, which included the comparative measure of spoken language exposure, showed small yet significant relationships between spoken language exposure and vocabulary knowledge. As there were only few findings with the spoken language indicators, it is possible that spoken language exposure is very

difficult to measure. It is likely more difficult for individuals to reliably estimate how much they listen to and communicate through spoken language compared to how much time they spend reading. Spoken language exposure is also likely to be more variable over time than reading habits, as supported by the reliability results in Chapter 2, showing some of the spoken language indicators had high negative test-retest reliability than the written language exposure measures. Perhaps this is why there is not an existing measure of spoken language exposure.

5.3.2 Experiments

This study utilised experimental methods to measure sentence comprehension and production. These measures were taken from previous research (Montag & MacDonald, 2014; e.g. Wells et al., 2009) and were originally created as cognitive psycholinguistic measures to capture specific units of language. Therefore, they are designed to uncover universal processes of language rather than capture individual differences. A lack of relationships between these measures and measures of individual differences have been found in previous studies (e.g. James, Fraundorf, Lee, & Watson, 2018). Therefore, some relationships may be present concerning individual differences in the current study that have not been captured using these particular measures of language.

5.4 Limitations

This study employed a self-report survey design to collect information on SES and language exposure. There is therefore the chance that respondents may not always report these accurately – either because the respondents are guessing, such as if they

are not sure of their parent's household income, or the respondents are answering in a socially desirable way, so in a way they believe will make them look better to the researcher. As reading is a highly valued activity in western cultures, respondents may exaggerate how long they spend reading each week. The inclusion of the ART is one way to try and avoid socially desirable answers as it is an indirect way of measuring exposure, without directly asking participants to report their reading habits.

Due to an error in setup of the sentence comprehension experiment in Study 2, data had to be removed in order to control the number of participants in each condition of the experiment. Therefore, this task had a smaller sample of participants compared to the other measures which could have contributed to the marginal effects found using this measure.

Data across both studies were collected from university students, with a large majority being female, and therefore, results found cannot be generalised beyond this sample. Additionally, as this study used a cross-sectional design, conclusions regarding causality cannot be drawn. Furthermore, the data collected for Study 1 was also used to assess the factor structure of the variables, along with tests of reliability. A separate dataset should have been collected to examine the research questions following factor structure and reliability analyses.

Finally, as this study focused on the experiential aspect of the language, it cannot account for the genetic factors that will play a role in language use.

5.5 Conclusion

The research reported in this thesis suggests a possible reduction in SES disparities in language skills as an individual enters adulthood. This is an encouraging

finding as it suggests that individuals from lower SES backgrounds can develop language skills as proficiently as individuals from high SES backgrounds despite the variability in input between high and low SES groups. Together with prior research, these results show the importance of experience with written language on the ability to process language accurately and efficiently, particularly for vocabulary knowledge. As these results show marginal effects of language exposure also predicting sentence comprehension and production skill, research to study this further is recommended.

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Appendices

Appendices: Socio-economic Status

Appendix 1: Familial Socio-economic Status Questions

Please indicate your **mother's** highest qualification level:

- ☐ No formal qualifications
- ☐ GCSEs or equivalent
- ☐ A-Levels or equivalent
- ☐ Post-18 vocational qualification
- ☐ Undergraduate degree
- ☐ Postgraduate degree
- ☐ Don't know

Please indicate your **father's** highest qualification level:

- ☐ No formal qualifications
- ☐ GCSEs or equivalent
- ☐ A-Levels or equivalent
- ☐ Post-18 vocational qualification
- ☐ Undergraduate degree
- ☐ Postgraduate degree
- ☐ Don't know

Please indicate your **mother's** occupational status:

- ☐ Manager, director or senior official occupation (e.g. business owner, CEO)
- ☐ Professional occupation (e.g. Health, teaching or research professional)
- ☐ Associate professional or technical occupation (e.g. operation/maintenance of equipment, IT services, protective services)
- ☐ Administrative or secretarial position
- ☐ Skilled trades occupation (e.g. agricultural, electric, construction, building trades)
- ☐ Caring, leisure or other service occupation (e.g. care of elderly, children or animals, travel, personal care and hygiene services)
- ☐ Sales or customer service occupation
- ☐ Process, plant or machine operative (e.g. operate and monitor machinery, assemble products)
- ☐ Elementary occupation (e.g. routine tasks, manufacturing or transportation labourers)
- ☐ Unemployed, full-time student or full-time parent
- ☐ Don't know

Please indicate your **father's** occupational status:

Please estimate the gross income of your family household:

- ☐ £0-£10,000
- ☐ £10,000-£20,000
- ☐ £20,000-£30,000
- ☐ £30,000-£40,000
- ☐ £40,000-£50,000
- ☐ £50,000-£60,000
- ☐ £60,000-£70,000
- ☐ £70,000-£80,000
- ☐ £80,000-£90,000
- ☐ £90,000-£100,000
- ☐ £100,000+
- ☐ Don't know

Appendix 2: Subjective Socio-economic Status Questions

Think of this ladder as representing where people stand in the UK. At the top of the ladder are the people who are the best off – those who have the most money, the most education, and the most respected jobs. At the bottom are the people who are the worst off – those who have the least money, least education, the least respected jobs, or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom.

Please indicate where you think you stand at this point in time relative to other people in the UK.

10

9

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3

2

1

Please indicate where you think you and your family stood on this ladder in your early childhood (0-5 years of age) relative to other people in the UK.

Please indicate where you think you and your family stood on this ladder in your later childhood (5-18 years of age) relative to other people in the UK.

Appendix 3: Sample Distributions for Familial SES Indicators in Study 1

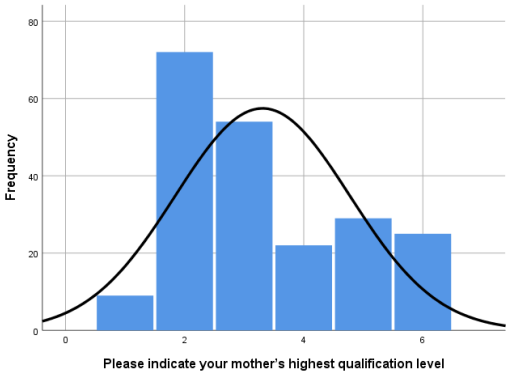


Figure 6.1
Distribution of Study 1 Mother's Education Indicator

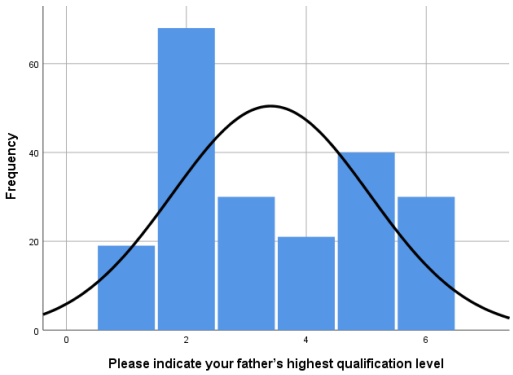


Figure 6.2
Distribution of Study 1 Father's Education Indicator

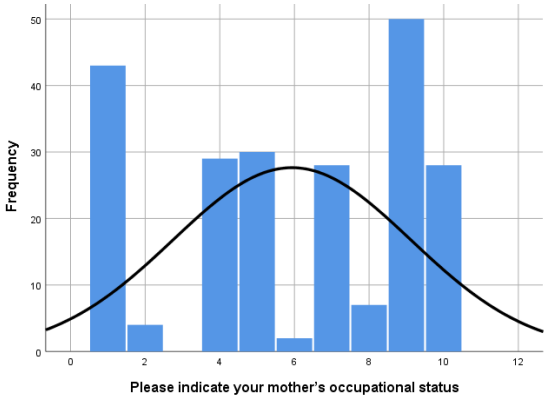


Figure 6.3
Distribution of Study 1 Mother's Occupation Indicator

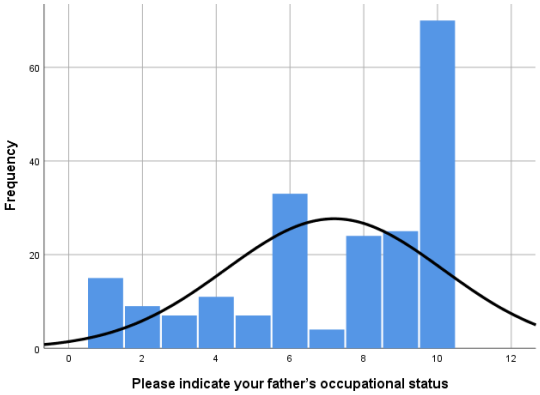


Figure 6.4
Distribution of Study 1 Father's Occupation Indicator

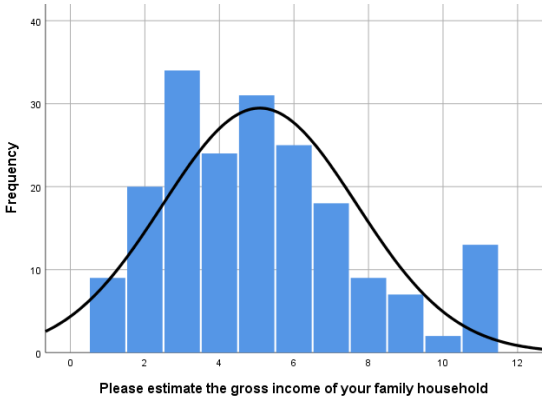


Figure 6.5
Distribution of Study 1 Household Income Indicator

Appendix 4: Sample Distributions for Objective and Subjective SES Indicators in Study 2

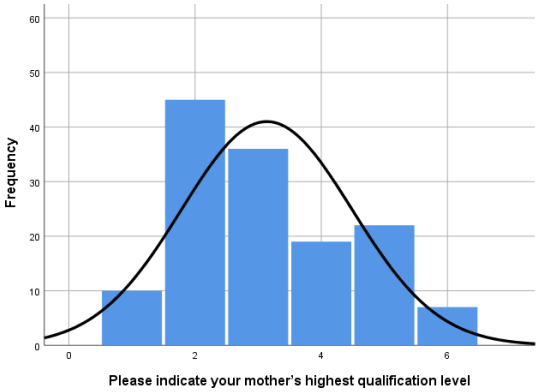


Figure 6.6
Distribution of Study 2 Mother's Education Indicator

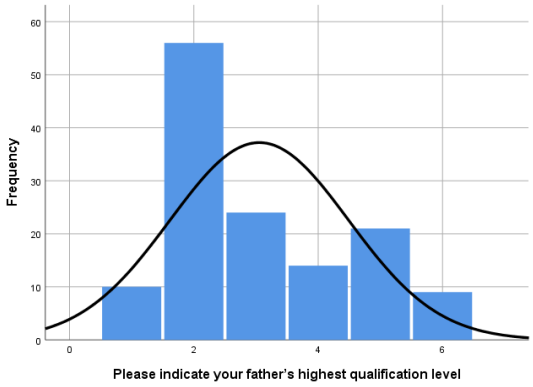


Figure 6.7
Distribution of Study 2 Father's Education Indicator

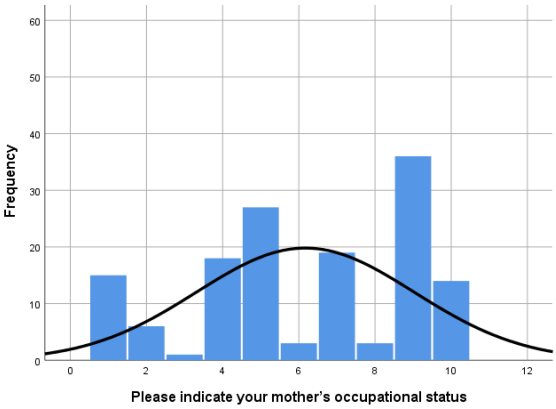


Figure 6.8
Distribution of Study 2 Mother's Occupation Indicator

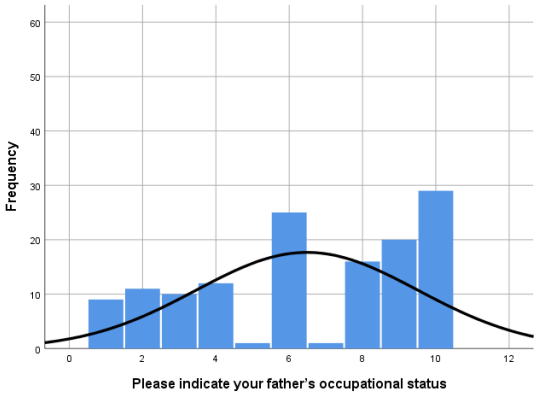


Figure 6.9
Distribution of Study 2 Father's Occupation Indicator

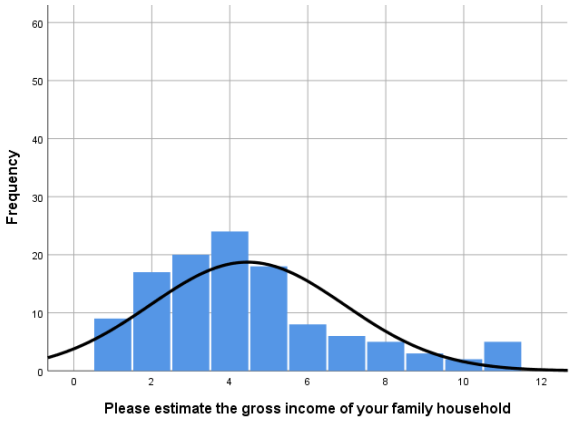


Figure 6.10
Distribution of Study 2 Household Income Indicator

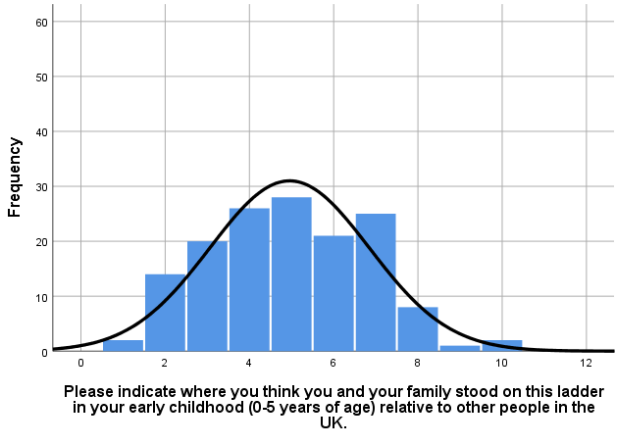


Figure 6.11
Distribution of Study 2 MacArthur SSS indicator (0-5 years)

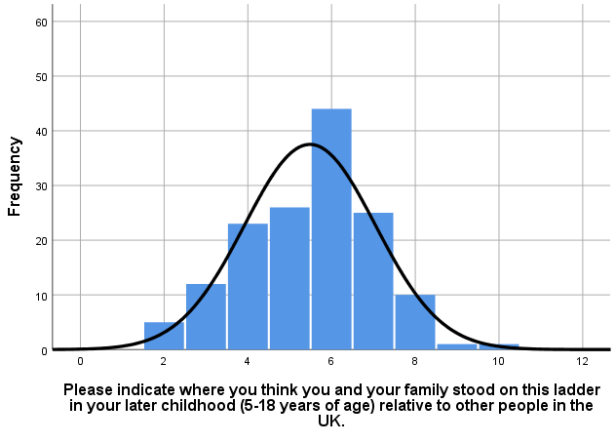


Figure 6.12
Distribution of Study 2 MacArthur SSS indicator (5-18 years)

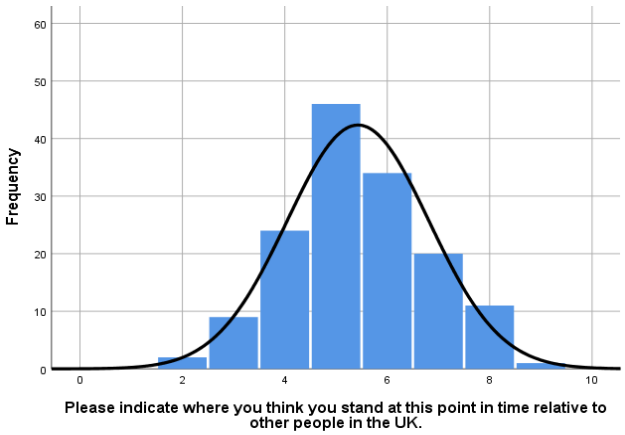
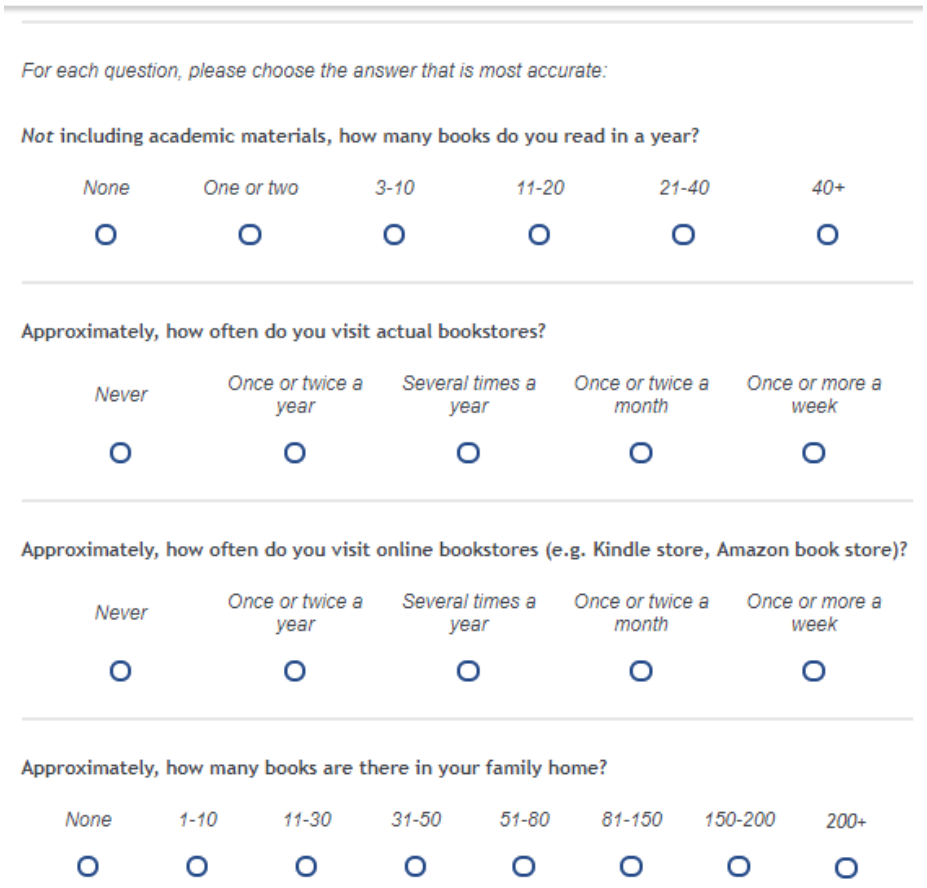


Figure 6.13
Distribution of Study 2 MacArthur SSS indicator (now)

Appendices: Language Exposure

Appendix 5: Reading habits Questions



For each question, please choose the answer that is most accurate:

Not including academic materials, how many books do you read in a year?

None	One or two	3-10	11-20	21-40	40+
O	O	O	O	O	O

Approximately, how often do you visit actual bookstores?

Never	Once or twice a year	Several times a year	Once or twice a month	Once or more a week
O	O	O	O	O

Approximately, how often do you visit online bookstores (e.g. Kindle store, Amazon book store)?

Never	Once or twice a year	Several times a year	Once or twice a month	Once or more a week
O	O	O	O	O

Approximately, how many books are there in your family home?

None	1-10	11-30	31-50	51-80	81-150	150-200	200+
O	O	O	O	O	O	O	O

Appendix 6: Comparative Reading Habits Questions

For each question, please choose the answer that is most accurate:

	Much less than others	*Less than others*	*About the same as others*	*More than others*	*Much more than others*
Compared to other people your age, how much time do you spend reading academic material?	○	○	○	○	○
Compared to other people your age, how much time do you spend reading fiction?	○	○	○	○	○
Compared to other people your age, how much time do you spend reading newspapers and magazines (in print or online)?	○	○	○	○	○
Compared to the reading material of other people your age, how complex do you think the non-academic material (e.g. fiction, newspapers) that you read is?	○	○	○	○	○
Compared to other people your age, how much do you enjoy reading?	○	○	○	○	○
Compared to other people your age, how much time do you spend on social media?	○	○	○	○	○

Appendix 7: Reading Time Questions

When you think of your typical week and how much time you spend reading, please indicate **how many hours (in a typical week)** you spend reading each of the materials below.

For each question, please choose the answer that is most accurate:

Textbooks:

0	1	2	3	4	5	6	*7+ hours per week*
○	○	○	○	○	○	○	○

Academic materials other than textbooks:

0	1	2	3	4	5	6	*7+ hours per week*
○	○	○	○	○	○	○	○

Fiction books:

0	1	2	3	4	5	6	*7+ hours per week*
○	○	○	○	○	○	○	○

Non-fiction/special interest books:

0	1	2	3	4	5	6	*7+ hours per week*
○	○	○	○	○	○	○	○

Other:

0	1	2	3	4	5	6	*7+ hours per week*
○	○	○	○	○	○	○	○

If other please indicate:

Appendix 8: Author Recognition Test

This list contains some names of authors of fiction books for adults and some unrelated names. Put a tick in the box beside the name of any author that you ***recognise*** *- you do not have to have read his or her books. You will receive* ***1 point*** *for selecting a correct author, and a* ***2 point deduction*** *for selecting an unrelated name - so please don't guess! If you are filling out this questionnaire outside of our lab, we trust that you will answer without consulting any external references (online or in print!).*

- ☐ Cecilia Ahern
- ☐ Martin Amis
- ☐ Maya Angelou
- ☐ Margaret Atwood
- ☐ Jane Austen
- ☐ Mark Bentley
- ☐ Ray Bradbury
- ☐ Piers Brazier
- ☐ Hadrian Briggs
- ☐ Matthew Brindley
- ☐ Charlotte Bronte
- ☐ Edward Burcher
- ☐ Florence Chamberlain
- ☐ Lee Child
- ☐ Tom Clancy
- ☐ Martina Cole
- ☐ Jackie Collins
- ☐ Caroline Crockett
- ☐ Monica Crowther
- ☐ Clive Cussler
- ☐ Richard Dade
- ☐ Charles Dickens
- ☐ Margaret Drabble
- ☐ Matthew Dyke
- ☐ Adrian Fendall
- ☐ F. Scott Fitzgerald
- ☐ James Gambold
- ☐ Sue Grafton
- ☐ John Grisham
- ☐ Thomas Hardy
- ☐ Paula Hawkins
- ☐ Ernest Hemingway
- ☐ Robin Herringshaw
- ☐ Gemma Hymas
- ☐ Kazuo Ishiguro
- ☐ James Joyce
- ☐ Stephen King
- ☐ Sophie Kinsella
- ☐ Sebastien Lauzier
- ☐ John Le Carré
- ☐ Harper Lee
- ☐ Robert Ludlum
- ☐ Dan Marcal
- ☐ Gabriel Garcia Marquez
- ☐ Val McDermid
- ☐ Ian McEwan
- ☐ Andy McNab
- ☐ Beth Motley
- ☐ Vladimir Nabokov
- ☐ Duncan Normington
- ☐ George Orwell
- ☐ James Patterson
- ☐ Tracy Payton
- ☐ Jodi Picoult
- ☐ Barnaby Pitts
- ☐ Ian Rankin
- ☐ Jemma Read
- ☐ Joseph Roberts
- ☐ Salman Rushdie
- ☐ George Savidge
- ☐ Danielle Steel
- ☐ Colin Stokes
- ☐ Eleanor Talbot
- ☐ Rose Tremain
- ☐ Guy Warner
- ☐ Lynette Webster
- ☐ Nicola Wellfair
- ☐ Madeline Whitaker
- ☐ Virginia Woolf
- ☐ Sophie Zadeh

Appendix 9: Names and selection rates for study 1 (N = 224) of real authors used in the Author Recognition Test, split by literary and popular authors.

Name	Selection Rate (%)	Name	Selection Rate (%)
Authors maintained from Moore and Gordon (2015)			
Literary		*Popular*	
Maya Angelou	20	Ray Bradbury	5
Margaret Atwood	26	Tom Clancy	32
F. Scott Fitzgerald	65	Jackie Collins	36
Ernest Hemingway	53	Clive Cussler	3
Kazuo Ishiguro	10	Sue Grafton	3
James Joyce	12	John Grisham	26
Harper Lee	49	Stephen King	80
Gabriel Garcia Marquez	4	Robert Ludlum	4
Vladimir Nabokov	7	James Patterson	31
George Orwell	61	Danielle Steel	25
Salman Rushdie	7		
Virginia Woolf	44		
		New Authors	
Martin Amis	3	Cecilia Ahern	16
Jane Austen	87	Lee Child	32
Charlotte Brontë	62	Martina Cole	30
Charles Dickens	88	Paula Hawkins	15
Margaret Drabble	1	Sophie Kinsella	16
Thomas Hardy	40	John Le Carré	8
Ian McEwan	21	Val McDermid	5
Rose Tremain	1	Andy McNab	30
		Jodi Picoult	27
		Ian Rankin	17

Appendix 10: Names and selection rates for study 2 (N = 147) of real authors used in the Author Recognition Test, split by literary and popular authors.

Name	Selection Rate (%)	Name	Selection Rate (%)
Authors maintained from Moore and Gordon (2015)			
Literary		*Popular*	
Maya Angelou	20	Ray Bradbury	7
Margaret Atwood	36	Tom Clancy	32
F. Scott Fitzgerald	73	Jackie Collins	33
Ernest Hemingway	58	Clive Cussler	2
Kazuo Ishiguro	10	Sue Grafton	1
James Joyce	14	John Grisham	24
Harper Lee	47	Stephen King	90
Gabriel Garcia Marquez	4	Robert Ludlum	4
Vladimir Nabokov	13	James Patterson	40
George Orwell	37	Danielle Steel	28
Salman Rushdie	10		
Virginia Woolf	53		
		New Authors	
Martin Amis	5	Cecilia Ahern	21
Jane Austen	87	Lee Child	30
Charlotte Brontë	64	Martina Cole	25
Charles Dickens	91	Paula Hawkins	6
Margaret Drabble	0	Sophie Kinsella	26
Thomas Hardy	35	John Le Carré	7
Ian McEwan	24	Val McDermid	2
Rose Tremain	2	Andy McNab	28
		Jodi Picoult	26
		Ian Rankin	16

Appendix 11: Example of Spoken Language Exposure Questions

Please indicate **how much time you typically spend** in the following contexts.

For each question, please choose the answer that is most accurate:

Talking with friends (face to face/ over the phone):

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*
○	○	○	○	○

Talking with family (face to face/ over the phone):

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*
○	○	○	○	○

Watching TV shows (e.g. live TV, catch-up TV, streaming websites such as Netflix):

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*
○	○	○	○	○

Watching online video clips (e.g. Youtube, video blogs):

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*
○	○	○	○	○

Internet media (e.g. online chat, forums):

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*
○	○	○	○	○

Appendix 12: Example Sentences for Each Syntactic Structure in the Individual Sentence Familiarity Rating Task

Word order	**Structure**	**Example Sentence**
Subject first	*Simple Intransitive*	The money disappeared.
	Prepositional Phrase	The waitress drove to the restaurant.
	To Infinitive Verb Phrase	The runner tried to achieve her goal.
	WH Clause	She couldn't remember where the party was.
	Sentential Complement (with Complementizer)	The father accepted that his daughter was getting married.
	Sentential Complement (no Complementizer)	Ruby hoped the shop was open.
	Perception Complement	Alex heard the bells ringing.
	Simple Transitive	The fireman carried the hose.
	Ditransitive	The company bought Leyla some flowers.
	Transitive + Prepositional Phrase	Jack pulled the ball out of the pond.
	Transitive + To Infinitive Verb Phrase	The receptionist advised us to wait.
	Transitive + WH clause	I asked what the assistant wanted.
	Subject Infinitive RC	The first scientist to understand gravity was an old man.
	Subject Relative Clause	The boy who helped Lucy was very young.
Object first	*Passive*	Janet was paid by a local company.
	Object Relative Clause	The senator who the reporter called was very experienced.
	Object Relative Clause (reduced)	The toy she wanted was expensive.
	Passive Relative Clause	The object that was found by the archaeologist was very unusual.
	Passive Relative Clause (reduced)	The actress mentioned by the journalist was famous.
	Object Infinitive RC	The equation to learn for Tuesday is on page 3.
	Passive Infinitive RC	The recital to be performed that afternoon was cancelled.

Appendix 13: Example of the Sentence Familiarity Rating Task Instructions

In this section, we will again ask you to rate how often you encounter different types of sentences. As a reminder, you will again be using a scale from 1 to 7 (1 = very rarely, 4 = sometimes, 7 = very often). To use the two examples below, for (a) you would likely choose 6 or 7, whereas for (b) you would likely choose 2 or 3. You may encounter some sentences more than sometimes but not very often, and so you would choose 5 or 6, and some sentences may be encountered more than very rarely and so you would choose 2 or 3.

(a) John ate a tomato pizza at the local restaurant yesterday.

Very rarely			*Sometimes*			*Very often*
1	2	3	4	5	6	7

(b) Yesterday, a tomato pizza was eaten by John at the local restaurant.

Very rarely			*Sometimes*			*Very often*
1	2	3	4	5	6	7

As before, we are interested here in the *type of sentence*, rather than the topic. As shown in the two examples above, they are both about John eating a tomato pizza, and you are likely to have encountered the first type of sentence (a) more often than the second sentence (b).

In the following task, we would again like you to rate how often you encounter that type of sentence. This time each sentence will be presented individually, and we would like you to rate it on its own, as soon as you read it.

Please make sure you have read the instructions carefully, and fully understand what you are required to do before you continue.

Appendix 14: Items from the Individual Sentence Familiarity Rating Task, in the order presented

	Sentence
1.	The cowboy realised it was about to rain.
2.	Noah pretended not to see the spider.
3.	The director to suggest for an award is currently in prison.
4.	Kim admitted that he had left.
5.	The pianist well played very.
6.	I asked what the assistant wanted.
7.	She couldn't remember where the party was.
8.	The event was described by the organisers.
9.	The company bought Leyla some flowers.
10.	The object that was found by the archaeologist was very unusual.
11.	Check on her neighbour after the storm had passed Anya went to.
12.	The toy she wanted was expensive
13.	The fireman carried the hose.
14.	The money disappeared.
15.	The equation to learn for Tuesday is on page 3.
16.	Jack pulled the ball out of the pond.
17.	The next contestant to answer correctly will get bonus points.
18.	The president hesitated.
19.	The observatory viewed from the science class the comet.
20.	Abi allowed Matt to borrow her scarf.
21.	The runner tried to achieve her goal.
22.	Alex heard the bells ringing.
23.	Janet was paid by a local company.
24.	The senator who the reporter called was very experienced.
25.	She had hair cut her short.
26.	Sarah pushed the suitcase towards the door.
27.	The astronomer pointed to the sky.
28.	The boy who helped Lucy was very young.
29.	The first scientist to understand gravity was an old man.
30.	Will excited about the party is.
31.	The receptionist advised us to wait.
32.	The award that was expected by Professor West was very prestigious.
33.	The recital to be performed that afternoon was cancelled.
34.	Stephen left school when he was fourteen.
35.	Bed she jumped on the.
36.	The man who wrote the book was a surgeon.
37.	The policeman was watching the crowd.
38.	The pride that the winner felt was overwhelming.
39.	He enjoyed racing car his.
40.	The issue to be discussed at the meeting was very complex.
41.	The actress mentioned by the journalist was famous.
42.	The game we played was easy.
43.	The father accepted that his daughter was getting married.
44.	The coach was the game watching.
45.	Ruby hoped the shop was open.
46.	Her grandma told her a nice story.
47.	The biker explained how the accident had happened.
48.	The student chosen by Mr. Hart passed the exam.
49.	The waitress drove to the restaurant.
50.	The pilot saw the lights flashing.

Appendix 15: Items from the Comparative Sentence Familiarity Rating Task, in the order presented

	Structure	Sentences	
1.	ORC/PRC	The award that was expected by Professor West was very prestigious.	The award that Professor West expected was very prestigious.
2.	Active/passive	The card was declined by the cash machine.	The cash machine declined the card.
3.	Active/passive	The entire house was painted by his father.	His dad painted the entire house.
4.	Ditransitive	The surgeon sent the patient the results.	The surgeon sent the results to the patient.
5.	ORC/PRC	The toy wanted by the child was expensive.	The toy the child wanted was expensive.
6.	Active/passive	The event was described by the organizers.	The organisers described the event.
7.	ORC/PRC	The boy being helped by Lucy is wearing a hat.	The boy Lucy is helping is wearing a hat.
8.	UG	He enjoyed racing his car.	He racing enjoyed car his.
9.	ORC/PRC	The child adopted by the couple was happy.	The child the couple adopted was happy.
10.	Active/passive	The memo was sent by the manager.	The manager sent the memo.
11.	Active/passive	The town was destroyed by fire.	Fire destroyed the town.
12.	Ditransitive	She showed the doctor her arm.	She showed her arm to the doctor.
13.	ORC/PRC	The politician who was called by the reporter was very experienced.	The politician who the reporter called was very experienced.
14.	Active/passive	The football was kicked by Luke.	Luke kicked the football.
15.	UG	Will is excited about the party.	Will is excited about the party.
16.	Active/passive	The hospital was powered by the generator.	The generator powered the hospital.
17.	Ditransitive	The teacher gave the students a test.	The teacher gave a test to the students.

Note: ORC = Object Relative Clause; PRC = Passive Relative Clause; UG = Ungrammatical

	Structure	Sentences	
18.	ORC/PRC	The pasta cooked by the chef was tasty.	The pasta the chef cooked was tasty.
19.	ORC/PRC	The mug that was stained by the tea was expensive.	The mug that the tea stained was expensive.
20.	UG	The pianist played very well.	The pianist well played very.
21.	ORC/PRC	The whales being watched by the passengers are very big.	The whales the passengers are watching are very big.
22.	ORC/PRC	The planet that was hit by the asteroid contained life.	The planet that the asteroid hit contained life.
23.	Ditransitive	We bought Sally a birthday cake.	We bought a birthday cake for Sally.
24.	UG	She jumped on the bed.	Bed she jumped on the.
25.	ORC/PRC	The actress mentioned by the journalist was famous.	The actress the journalist mentioned was famous.
26.	Ditransitive	He handed Dan the pencil.	He handed the pencil to Dan.
27.	ORC/PRC	The student chosen by Mr. Hart passed the exam.	The student Mr Hart chose passed the exam.
28.	ORC/PRC	The cottage that was hidden by the trees was shabby.	The cottage that the trees hid was shabby.
29.	Active/passive	Janet was paid by a local company.	A local company paid Janet.
30.	UG	She had her hair cut short.	She had hair cut her short.
31.	Active/passive	The cadet was scolded by the sergeant.	The sergeant scolded the cadet.
32.	Ditransitive	The vicar threw the girl the frisbee.	The vicar threw the frisbee to the girl.
33.	Active/passive	The mechanic was asked by Tom to fix the car.	Tom asked the mechanic to fix the car.
34.	UG	The coach was watching the game.	The coach was the game watching.
35.	Active/passive	The singer was praised by the audience.	The audience praised the singer.
36.	Active/passive	The apprentice was trained by the chef.	The chef trained the apprentice.
37.	Ditransitive	He read his son the book.	He read the book to his son.

Note: ORC = Object Relative Clause; PRC = Passive Relative Clause; UG = Ungrammatical

	Structure	Sentences	
38.	UG	The science class viewed the comet from the observatory.	The observatory viewed from the science class the comet.
39.	ORC/PRC	The photographer hired by her was experienced.	The photographer she hired was experienced.
40.	ORC/PRC	The object the was found by the archaeologist was very unusual.	The object that the archaeologist found was very unusual.
41.	Ditransitive	David told the children a story.	David told a story to the children.
42.	ORC/PRC	The pride the winner felt was overwhelming.	The pride that was felt by the winner was overwhelming.
43.	UG	Anya went to check on her neighbour after the storm had passed.	Check on her neighbour after the storm had passed Anya went to.
44.	Active/passive	The cliff was eroded by the sea.	The sea eroded the cliff.

Note: ORC = Object Relative Clause; PRC = Passive Relative Clause; UG = Ungrammatical

Appendix 16: Comparative Spoken Language Exposure Questions

Please indicate **how much time you typically spend communicating with other people** in the following contexts. Each question asks you to compare yourself to other people your age.

For each question, please choose the answer that is most accurate:

	Much less than others	*Less than others*	*About the same as others*	*More than others*	*Much more than others*
Compared to other people your age, how much time do you spend talking with friends (face to face/ over the phone/video chat)?	○	○	○	○	○
Compared to other people your age, how much time do you spend talking with family (face to face/ over the phone/video chat)?	○	○	○	○	○
Compared to other people your age, how much time do you spend instant messaging (e.g. Facebook Messenger, Whatsapp, Snapchat)?	○	○	○	○	○
Compared to other people you age, how much time do you spend texting (phone communication without the need for an app or internet connection)?	○	○	○	○	○
Compared to other people your age, how much time do you spend talking to other players whilst playing online games (e.g. speaking using a microphone)?	○	○	○	○	○

Please indicate **how much time you typically spend listening to spoken language** in the following contexts. Each question asks you to compare yourself to other people your age.

For each question, please choose the answer that is most accurate:

	Much less than others	*Less than others*	*About the same as others*	*More than others*	*Much more than others*
Compared to other people your age, how much time do you spend watching TV shows/films (e.g. live TV, catch-up TV, streaming websites such as Netflix)?	○	○	○	○	○
Compared to other people your age, how much time do you spend watching online video clips (e.g. Youtube, video blogs)?	○	○	○	○	○
Compared to other people you age, how much time do you spend listening to music (with lyrics)?	○	○	○	○	○
Compared to other people your age, how much time do you spend listening to podcasts?	○	○	○	○	○
Compared to other people your age, how much time do you spend listening to audiobooks?	○	○	○	○	○

Approximately, how much time do you spend verbally interacting with other people?

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*

Approximately, how much time do you spend listening to spoken language (not including spoken interactions, such as watching TV shows/films or listening to audio books?

Never	*1 hour or less a week*	*2 to 5 hours a week*	*1 hour or less a day*	*Several hours a day*

Appendices: Measures of Language Use

Appendix 17: Example of WASI-II Vocabulary Test

Appendix 18: Example Items from the Nelson-Denny Vocabulary Subtest

1. To *explain* something is to: A. make it clear B. say it C. reveal it D. confuse it E. compare it ..... 1.

2. To be *elastic* is to be: F. rigid G. rigorous H. elated I. expandable J. exacting ..... 2.

3. *Similarities* are: A. samples B. likenesses C. differences D. simplicities E. specialities ... 3.

4. *Massive* rock formations are: F. huge G. jagged H. smooth I. colorful J. steep ..... 4.

5. *Resources* are: A. available means B. occurrences C. situations D. reasons E. restorations ..... 5.

6. A *quest* is a: F. doubt G. cause H. twist I. question J. search ..... 6.

7. A *replication* is a: A. composition B. copy C. lie D. speech E. dramatic production ..... 7.

8. *Migration* is: F. farming G. mixing H. communicating I. chewing J. moving ..... 8.

9. *Dependence* means: A. incompetence B. change C. reliance D. corruption E. protection .. 9.

10. To *alter* means to: F. reap G. include H. change I. astonish J. accept ..... 10.

11. Meat that is *tasteless* is: A. scarce B. without seasoning C. stale D. without flavor E. rare ..... 11.

12. To end *abruptly* is to end: F. slowly G. cautiously H. quickly I. angrily J. smoothly .... 12.

13. To *grasp* is to: A. choke B. sting C. bite D. seize E. glide ..... 13.

14. *Segments* are: F. fragments G. tenants H. signals I. sets J. seasons ..... 14.

Appendix 19: A List of Items Used in the LexTALE Vocabulary Test

Item number	Item	Word status	Item number	Item	Word status
Practice	Platery	Nonword	31	Plaintively	Word
Practice	Denial	Word	32	Kilp	Nonword
Practice	Generic	Word	33	Interfate	Nonword
1	Mensible	Nonword	34	Hasty	Word
2	Scornful	Word	35	Lengthy	Word
3	Stoutly	Word	36	Fray	Word
4	Ablaze	Word	37	Crumper	Nonword
5	Kermshaw	Nonword	38	Upkeep	Word
6	Moonlit	Word	39	Majestic	Word
7	Lofty	Word	40	Magrity	Nonword
8	Hurricane	Word	41	Nourishment	Word
9	Flaw	Word	42	Abergy	Nonword
10	Alberation	Nonword	43	Proom	Nonword
11	Unkempt	Word	44	Turmoil	Word
12	Breeding	Word	45	Carbohydrate	Word
13	Festivity	Word	46	Scholar	Word
14	Screech	Word	47	Turtle	Word
15	Savoury	Word	48	Fellick	Nonword
16	Plaudate	Nonword	49	Destription	Nonword
17	Shin	Word	50	Cylinder	Word
18	fluid	Word	51	Censorship	Word
19	Spaunch	Nonword	52	Celestial	Word
20	Allied	Word	53	Rascal	Word
21	Slain	Word	54	Purrage	Nonword
22	Recipient	Word	55	Pulsh	Nonword
23	Exprate	Nonword	56	Muddy	Word
24	Eloquence	Word	57	Quirty	Nonword
25	Cleanliness	Word	58	Pudour	Nonword
26	Dispatch	Word	59	Listless	Word
27	Rebondicate	Nonword	60	Wrought	Word
28	Ingenious	Word			
29	Bewitch	Word			
30	skave	Nonword			

Appendix 20: Example Items from the CELF-5 Recalling Sentences Subtest

Trial 1 My sister is in Year 6.

Trial 2 Does Mr. Singh teach reading?	0 errors	1 error	2 or 3 errors	4+ errors
Ages 15–21				
16. The pupil who won the award at the art show was very excited.	3	2	1	0
17. The class that sells the most tickets to the dance will win a prize.	3	2	1	0
18. After the students had finished the book, the teacher asked them to write a review.	3	2	1	0
19. If we had gone straight home after the match, we would not have missed our curfew.	3	2	1	0

Appendix 21: Experimental Sentences Used in the Sentence Comprehension Experiment

List 1	List 2	Comprehension Question
The banker that the barber praised climbed the mountain just outside of town.	The banker that praised the barber climbed the mountain just outside of town.	Did the banker climb the mountain?
The lawyer that the reporter phoned cooked the pork chops in their own juices.	The lawyer that phoned the reporter cooked the pork chops in their own juices.	Did the reporter cook the pork chops?
The salesman that the fireman liked dominated the conversation about the race.	The salesman that liked the fireman dominated the conversation about the race.	Did the salesman like the fireman?
The waiter that the broker despised drove the sportscar home from work that evening.	The waiter that despised the broker drove the sportscar home from work that evening.	Did the broker despise the waiter?
The poet that the painter inspired wrote an autobiography after their friendship became well known.	The poet that inspired the painter wrote an autobiography after their friendship became well known.	Did the poet write an autobiography?
The chef that the cashier distrusted called for help after the restaurant closed.	The chef that distrusted that cashier called for help after the restaurant closed.	Did the cashier call for help?
The aunt that the child amused made paper dolls out of the newspaper.	The aunt that amused the child made paper dolls out of the newspaper.	Did the child amuse the aunt?
The teacher that the student questioned wrote a long science fiction novel during the summer vacation.	The teacher that questioned the student wrote a long science fiction novel during the summer vacation.	Did the teacher question the student?
The tailor that the customer described worked in a small building near the bus station.	The tailor that described the customer worked in a small building near the bus station.	Did the tailor work in a small building near the bus station?
The admiral that the general advised reminisced nostalgically before the trip got underway.	The admiral that advised the general reminisced nostalgically before the trip got underway.	Did the general advise the admiral?
The teacher that the headmaster annoyed decided to retire next year.	The teacher that annoyed the headmaster decided to retire next year.	Did the teacher decide to retire?
The assistant that the boss upset worked in a law firm for several years.	The assistant that upset the boss worked in a law firm for several years.	Did the boss work in a law firm for several years?

List 1	List 2	Comprehension Question
The visitor that the woman introduced traveled from France the week before.	The visitor that introduced the woman traveled from France the week before.	Did the woman introduce the visitor
The secretary that the employee phoned complained about her co-workers.	The secretary that phoned the employee complained about her co-workers.	Did the secretary phone the employee?
The policeman that the teenager alarmed received several phone calls that night.	The policeman that alarmed the teenager received several phone calls that night.	Did the teenager receive several phone calls?
The guard that the prisoner killed was a very friendly person.	The guard that killed the prisoner was a very friendly person.	Did the guard kill the prisoner?
The sailor that the mermaid spotted wondered how long the storm would last.	The sailor that spotted the mermaid wondered how long the storm would last.	Did the sailor wonder how long the storm would last?
The chef that the waitress married hoped to have children in the near future.	The chef that married the waitress hoped to have children in the near future.	Did the princess hope to have children in the near future?
The director that the cameraman assisted baked a huge birthday cake for his daughter.	The director that assisted the cameraman baked a huge birthday cake for his daughter.	Did the cameraman assist the director?
The captain that the commander trusted remained loyal to the rest of the team.	The captain that trusted the commander remained loyal to the rest of the team.	Did the captain trust the soldier?
The detective that disliked the teacher clipped the coupons out with the dull scissors.	The detective that the teacher disliked clipped the coupons out with the dull scissors.	Did the detective clip the coupons?
The judge that ignored the doctor watched the movie about Columbian drug dealers.	The judge that the doctor ignored watched the movie about Columbian drug dealers.	Did the doctor watch the movie?
The robber that insulted the accountant read the newspaper article about the fire.	The robber that the accountant insulted read the newspaper article about the fire.	Did the robber insult the accountant?
The governor that admired the comedian answered the telephone in the fancy restaurant.	The governor that the comedian admired answered the telephone in the fancy restaurant.	Did the comedian admire the governor?
The violinist that complimented the conductor performed at Carnegie Hall for two weeks.	The violinist that the conductor complimented performed at Carnegie Hall for two weeks.	Did the conductor perform at Carnegie Hall?

List 1	List 2	Comprehension Question
The actor that thanked the director worked in many hit movies.	The actor that the director thanked worked in many hit movies.	Did the director thank the actor?
The coach that criticized the referee talked publicly about the incident after the game.	The coach that the referee criticized talked publicly about the incident after the game.	Did the coach talk publicly about the incident?
The lawyer that interviewed the client owned a very small office.	The lawyer that the client interviewed owned a very small office.	Did the client own a very small office?
The plumber that called the electrician drove a large grey truck.	The plumber that the electrician called drove a large grey truck.	Did the plumber call the electrician?
The clerk that helped the traveler worked in a large foreign bank.	The clerk that the traveler helped worked in a large foreign bank.	Did the traveler help the clerk?
The trader that questioned the banker started a new business abroad.	The trader that the banker questioned started a new business abroad.	Did the trader question the banker?
The doctor that the nurse dated asked to be considered for the new position.	The doctor that dated the nurse asked to be considered for the new position.	Did the doctor ask to be considered for the new position?
The diplomat that the official consulted resigned because of some personal reasons.	The diplomat that consulted the official resigned because of some personal reasons.	Did the official resign?
The accountant that the chairman irritated had arrived at the company years ago.	The accountant that irritated the chairman arrived at the company years ago	Did the accountant arrive at the company years ago?
The administrator that amused the novice was considered a nice person.	The administrator that the novice amused was considered a nice person.	Did the novice amuse the administrator?
The gardener that envied the homeowner bought a large number of items in the sale.	The gardener that the homeowner envied bought a large number of items in the sale.	Did the gardener envy the homeowner?
The girl that approached the clown wore bright colours to the party.	The girl that the clown approached wore bright colours to the party.	Did the clown approach the girl?
The soldier that advised the doctor witnessed many deaths in his career.	The soldier that the doctor advised witnessed many deaths in his career.	Did the soldier witness many deaths?

List 1	List 2	Comprehension Question
The gymnast that adored the ballerina trained constantly to become the best.	The gymnast that the ballerina adored trained constantly to become the best.	Did the ballerina train constantly?
The plumber that consulted the builder inherited the family business many years ago.	The plumber that the builder consulted inherited the family business many years ago.	Did the plumber consult the builder?

Appendix 22: Filler Sentences Used in the Sentence Comprehension Experiment

Sentence	Comprehension Question
After the chef found supplies, he began cooking omelettes for the banquet.	Did the chef find the banquet?
After the milestone was celebrated, the couple settled down to admire the brilliant fireworks.	Did the couple avoid the fireworks?
After years of hard work at her entry-level position, the dedicated secretary finally advanced to a better-paying position.	Did the secretary advance?
Although the potatoes were shredded very carefully by the assistant cook, they came out unevenly and were unattractive.	Were the potatoes attractive?
Because she attributed her success to her Oxbridge education, the well-known politician awarded a large scholarship each year.	Did the politician give a scholarship each year?
Because the man was pestered about his significant money shortage, he booked a flight out of the country to avoid the tax office.	Did the man book a flight?
It was ruled that the institute must publicise the findings to prevent itself from appearing biased in any way.	Did the institute prevent something?
Once he achieved the status of Eagle Scout, the young man considered himself to be an example of a model teenage boy.	Did the young man fail to become an Eagle scout?
Once the scientist completed teaching the molecular biology course, the interests of her students were aroused.	Were the students interested after the course?
Soon after the wedding, the newlyweds decided to move out of their city apartment.	Did the newlyweds decide to move to the city?
The advisor considered the answer to be very complicated.	Did the advisor complicate the answer?
The agent hinted that the client was cheating on his taxes.	Did the client hint something?

Sentence	Comprehension Question
The agent muttered that the problem would make life very difficult.	Did the agent mutter something?
The album near the stereo with the volume display was recorded by the singer.	Did someone record the album?
The applicant proclaimed that the interviewer had been dishonest with her.	Did the interviewer distrust the applicant?
The apprentice cherished the possbility that the skill would be marketable.	Did the apprentice cherish something?
The artist in the studio with brick walls was humiliated by the incident.	Did something humiliate the artist?
The athlete in the only local gym with vaulted ceilings was traded by the promoter.	Did the promoter trade a trainer?
The author noted that the error should have been resolved earlier.	Did the author note that the mistake should have been resolved?
The bed in the French castle with torture chambers was carved by the prince.	Did the prince carve the bed?
The beggar near the house with storm windows was uncovered by the police.	Did the police uncover the house?
The biologist in the lab with open windows was surprised by the result.	Did the result surprise the biologist.
The book in the only library with card catalogs was copied by the researcher.	Did the researcher copy the magazine?
The boxer in the sauna with wooden panelling was eliminated by the challenger.	Did the challenger eliminate the boxer?
The bus driver pretended that the shift was almost over.	Did the bus driver pretend something?

Sentence	Comprehension Question
The bush by the cemetery tower with steep stairs was pruned by the groundskeeper.	Did the groundskeeper burn the bush?
The champion wished that the award would go to his brother.	Did the champion wish something?
The city by the western river with white-water rafting was destroyed by the flood.	Did the flood destroy the river?
The client conceded that the point might come up in court.	Did the client argue something?
The computer down the only hall with drinking fountains was used by the programmer.	Did someone use the computer?
The cooks gossiped that the manager flirted with everyone to amuse herself while working at the restaurant.	Did the cooks gossip about something?
The corporation proved that the workers picketed the policy to establish a positive public image.	Did the workers picket the policy?
The criminal in a jail with tall towers was detained by the guard.	Did the criminal escape?
The defendant decided that the appeal should be started right away.	Did the defendent dismiss something?
The desk at the company's headquarters with tennis courts was used by the consultant.	Did the consultant use the desk?
The director confirmed that the rumour should have been ended sooner.	Did the director confirm something?
The driver on the school bus with radial tires was rewarded by the superintendent.	Did the driver reward the superintendent?
The editor printed that the article had been slanderous to his reputation.	Did the editor print something about the article?

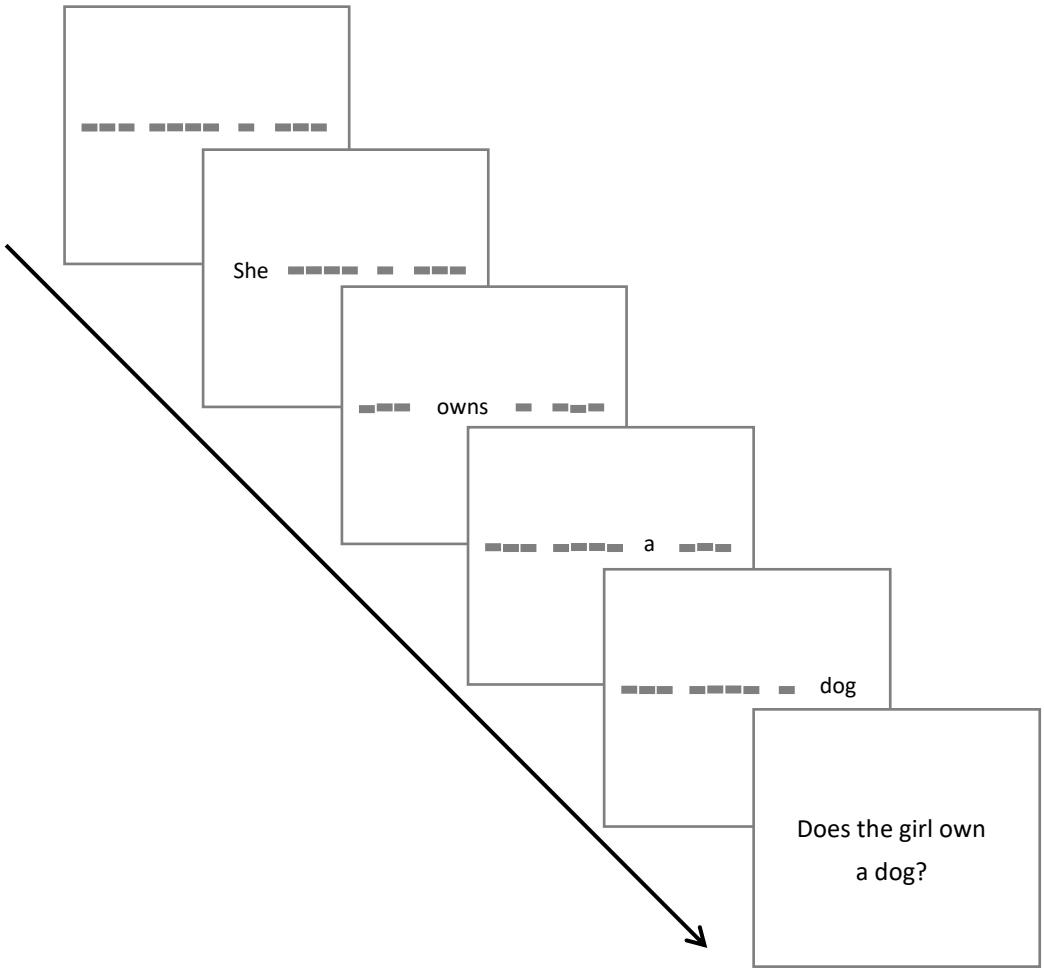
Sentence	Comprehension Question
The editor said that the truth needed to be made public.	Did the editor say something?
The engineer demonstrated that the machinery would be hard to destroy.	Did the engineer demonstrate that the equipment was designed to withstand destruction?
The engineer understood that the mistake would cost someone some money.	Did the engineer understand something?
The executive projected that the speech would not go very well.	Did the executive project something?
The father displayed how the problems were continuing to worsen.	Did the father deny something?
The fence around the yard with maple trees was erected by the settlers.	Did the settlers erect the fence?
The gardener allowed that the lawn was in good shape.	Did the gardener allow something?
The girl confided that the secret had been really bothering her.	Did the girl bother someone?
The glass by the office coffeepot with automatic shutoff was destroyed by the secretary.	Did the secretary destroy the coffeepot?
The guard meant that the robbery had been his own idea.	Did the guard meet the robber?
The handyman by the kitchen sink with clogged spouts was hired by the owner.	Did the handyman hire someone?
The horse in the Jensens' stable with overhead beams was ridden by the jockey.	Did Jensen ride the horse?
The hospital included that the gentleman demanded a second option to protect himself against a possible lawsuit.	Did the hospital state that the gentleman needed no second opinion?

Sentence	Comprehension Question
The landlord asserted that the girl faked the injury to guarantee herself a reasonable settlement in the case.	Did the landlord guarantee a reasonable settlement?
The law office in the firm with national recognition was sued by the client.	Did the client sue the law office?
The lion in the only zoo with bicycle ramps was domesticated by the circus.	Did the circus domesticate the lion?
The man repeated that the directions would need to be clarified.	Did the man repeat something about the directions?
The manager indicated that the problem would affect the whole office.	Did the manager affect something?
The motorbike by the toolshed with window shades was wrecked by the boy.	Did the boy wreck the toolshed?
The music in the adjacent club with free admission was played by the D.J.	Did the D.J. play the music in the club?
The negotiator sensed that the conflict would probably not get resolved.	Did the negotiator sense something?
The neighbours said that the arsonists set the fire to get themselves into the news reports.	Did the neighbours get themselves into the news reports?
The novelist inferred that the material would make some people unhappy.	Did the novelist infer that the material would do something?
The number on the calculator with faulty wiring was computed by the scientist.	Did the scientist compute something?
The officer guessed that the name had been written very hastily.	Did the officer guess something?
The official hinted that the woman arranged the meeting to get herself more time on the air.	Did the official want more time on the air?

Sentence	Comprehension Question
The park behind the main building with service lifts was leased by the agency.	Did the agency lease the building?
The patient on the crutches with rubber tips was impressed with the poem.	Did the patient write a poem?
The poet affirmed that his childhood was very unhappy.	Did the poet affirm something?
The priest asserted that the belief would be hard to justify.	Did the priest feel that the belief was commonly held?
The sales agent boasted that the memo was from the owner of the company.	Did the owner boast about something?
The salesman figured that the prices would be going up soon.	Did the salesman think that prices would remain constant?
The scientist insisted that the hypothesis was being contemplated.	Did the scientist deny something?
The scientist submitted that the theory had not been sufficiently outlined.	Did the scientist submit the theory?
The socks in the rural laundrette with vending machines were left by the athlete.	Did the athlete leave the socks behind?
The suspect added that the alibi had been a blatant lie.	Did the suspect add something?
The taxi driver assumed that the blame belonged to the other driver.	Did the taxi driver assume something?
The tenant in the upstairs apartment with termite damage was complicated by the owner.	Did the tenant own the apartment?
The visitor to the class with weekly readings was pleased with the attention.	Did the attention please the visitor?

Sentence	Comprehension Question
The waiter confirmed that the reservation was made yesterday.	Did the waiter state that no reservation was made?
Though the young woman clutched her purse carefully while in the large and unfamiliar city, it was nevertheless stolen.	Was the purse stolen?
Within thirty seconds of spilling the juice, the child was cleaning the carpet to prevent a stain.	Did the juice miss the carpet?

Appendix 23: Procedure of the Sentence Comprehension Experiment



Appendix 24: List of Words and Phrases in the Sentence Comprehension Experiment That Were Adapted to British English

Original Word/Phrase	Adapted Word/Phrase	Sentence in which the word was used
Busboy	Waiter	The waiter that despised the broker drove the sportscar home from work that evening
Cab	Taxi	The taxi driver assumed that the blame belonged to the other driver.
Diner	Restaurant	The cooks gossiped that the manager flirted with everyone to amuse herself while working at the restaurant.
Downton	City centre	Soon after the wedding, the newlyweds decided to move out of their city centre apartment.
Freight elevators	Service lifts	The park behind the main building with the service lifts was leased by the agency.
IRS	Tax office	Because the man was pestered about his significant money shortage, he booked a flight out of the country to avoid the tax office.
Ivy league	Oxbridge	Because she attributed her success to her Oxbridge education, the well-known politician awarded a large scholarship each year.
Laundromat	Laundrette	The socks in the rural laundrette with vending machines were left by the athlete.
Principal	Headmaster	The teacher that the headmaster annoyed decided to retire next year.
Senator	Official	The official hinted that the woman arranged the meeting to get herself more time on the air.
Vagrant	Beggar	The beggar near the house with storm windows was uncovered by the police.

Appendix 25: Unadjusted Mean Reading Times (ms) and Standard Deviations for Experimental Sentences in the Sentence Comprehension Experiment, Split by Relative Clause Type

	Region 1	Region 2	Region 3	Region 4
SRC	397 (153)	430 (307)	459 (311)	395 (160)
ORC	380 (140)	493 (643)	507 (380)	422 (227)

Note: Mean (Standard deviation)

Appendix 26: List of Questions for the Online Language Production Task

Test items

Word	List 1 question	List 2 question
Bury	Who has grey hair?	What is orange?
Carry	What is white?	Who is wearing a red t-shirt?
Cut	Who is wearing purple?	What is green without leaves?
Hit	What is pink?	Who is wearing purple?
Hold	Who is wearing pink?	What is green?
Hug	What is white?	Who is wearing green?
Kick	Who is wearing blue?	What is orange?
Kiss	What is yellow?	Who has black hair?
Lift	Who is bald?	What is grey?
Paint	What is grey?	Who is wearing a green t-shirt?
Pull	Who is wearing white?	What is blue?
Punch	What is orange?	Who is bald?
Push	Who is wearing a red dress?	What has green wheels?
Shoot	What is blue with a red centre?	Who is wearing a green jumper?
Splash	Who is not wearing a t-shirt?	What is green?
Spray	Who is wearing blue shoes?	What is the bird sitting on?
Throw	What is red?	Who is wearing an orange shirt?
Tie	What is blue?	Who is wearing a red jumper?
Touch	Who is wearing a black jacket?	What is green?
Wipe	What is light blue?	Who is wearing a white t-shirt?

Filler items

Word	Question
Filler bake	What is the man wearing green holding?
Filler bakery	What is the police officer buying?
Filler ball	What is the boy throwing to the girl?
Filler band	What are these men doing?
Filler bite	What is the dog with the blue collar doing?
Filler borrow	What is the woman giving the girl?
Filler bowling	What are these men doing?
Filler brush	What is the man wearing the red jacket doing?
Filler cards	What are these people doing?
Filler catch	What is the man wearing white shorts doing?
Filler cellphone	What is the man wearing a blue suit doing?
Filler chase	What is the rabbit doing?
Filler chop	What is this man holding?
Filler cockpit	What are the pilots doing?
Filler drink	What is the girl wearing green trousers doing?
Filler eat	What is the red fish doing?
Filler farm	What are the animals eating?
Filler feedpets	What has this girl just finished doing?
Filler fencing	What are these men doing?
Filler film	What is the woman wearing blue doing?
Filler fountain	What are these people looking at?
Filler grocery	Where are these people?
Filler hide	What is the boy with blond hair holding?
Filler iron	What is this woman doing?
Filler jump	What is the man wearing a yellow vest doing?
Filler keepaway	What is the boy holding?
Filler library	What is the woman wearing a yellow suit holding?
Filler lick	What is the gray dog doing?
Filler office	What is on the desk?
Filler photo	What is the man photographing?
Filler piano	What is the man doing?
Filler picnic	Who is having a picnic?

Filler pinch	What is the red lobster doing?
Filler play	What are the children doing?
Filler serve	What is on the womans tray?
Filler sit	What is the woman wearing a red dress doing?
Filler skate	What are the children doing?
Filler stepon	What is the boy wearing a green jumper doing?
Filler study	What is the woman wearing a yellow shirt doing?
Filler surf	What is the man doing?
Filler swim	What is the man swimming toward?
Filler teach	Where are these people?
Filler waiter	What is on top of the woman’s table?
Filler wash	What is the woman wearing a purple t-shirt doing?
Filler window	What is the woman doing?

Appendix 27: An Example Item from the Nelson-Denny Comprehension Subtest

PASSAGE TWO

Many insects communicate through sound. Male crickets use sound to attract females and to warn other males away from their territories. They rub a scraper on one forewing against a vein on the other forewing to produce chirping sounds. Each cricket species produces several calls that differ from those of other cricket species. In fact, because many species look similar, entomologists often use the calls to identify the species. Mosquitoes depend on sound, too. Males that are ready to mate home in on the buzzing sounds produced by females. The male senses this buzzing by means of tiny hairs on his antennae, which vibrate only to the frequency emitted by a female of the same species.

Insects may also communicate by tapping, rubbing, or signaling. Fireflies use flashes of light to find a mate. Each species of firefly has its own pattern of flashes. Males emit flashes in flight, and females flash back in response. This behavior allows male fireflies to locate a mate of the proper species. However, they must beware of female fireflies of the genus *Photuris,* which can mimic the flashes of other species. If a male of a different species responds to the flash of a *Photuris* female and attempts to mate, the female devours him. This is surely one of the more unusual behavioral adaptations in the enormously successful world of insects.

9. When male fireflies emit flashes,
   A. female fireflies ignore them.
   B. they become fatigued within one hour.
   C. other insects fly away immediately.
   D. female fireflies flash back to them.
   E. they exhaust their food supply.

10. Male mosquitoes use the buzzing sound produced by females to
   F. locate food.
   G. locate water.
   H. identify a mate.
   I. accompany their "songs."
   J. drown out their "songs."

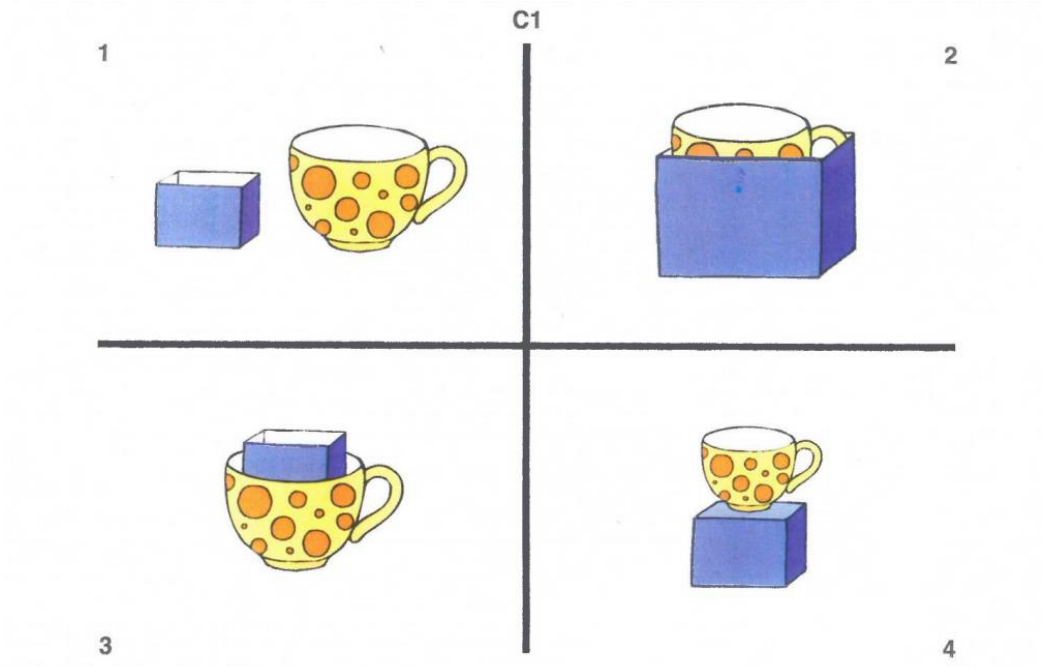
11. Male crickets use sound to
   A. call other males.
   B. frighten off females.
   C. corral their offspring.
   D. confuse their predators.
   E. attract their mates.

12. Fireflies of the genus *Photuris* can
   F. be easily caught.
   G. be impostors.
   H. grow unusually large.
   I. flash brighter than other fireflies.
   J. be found in all climates.

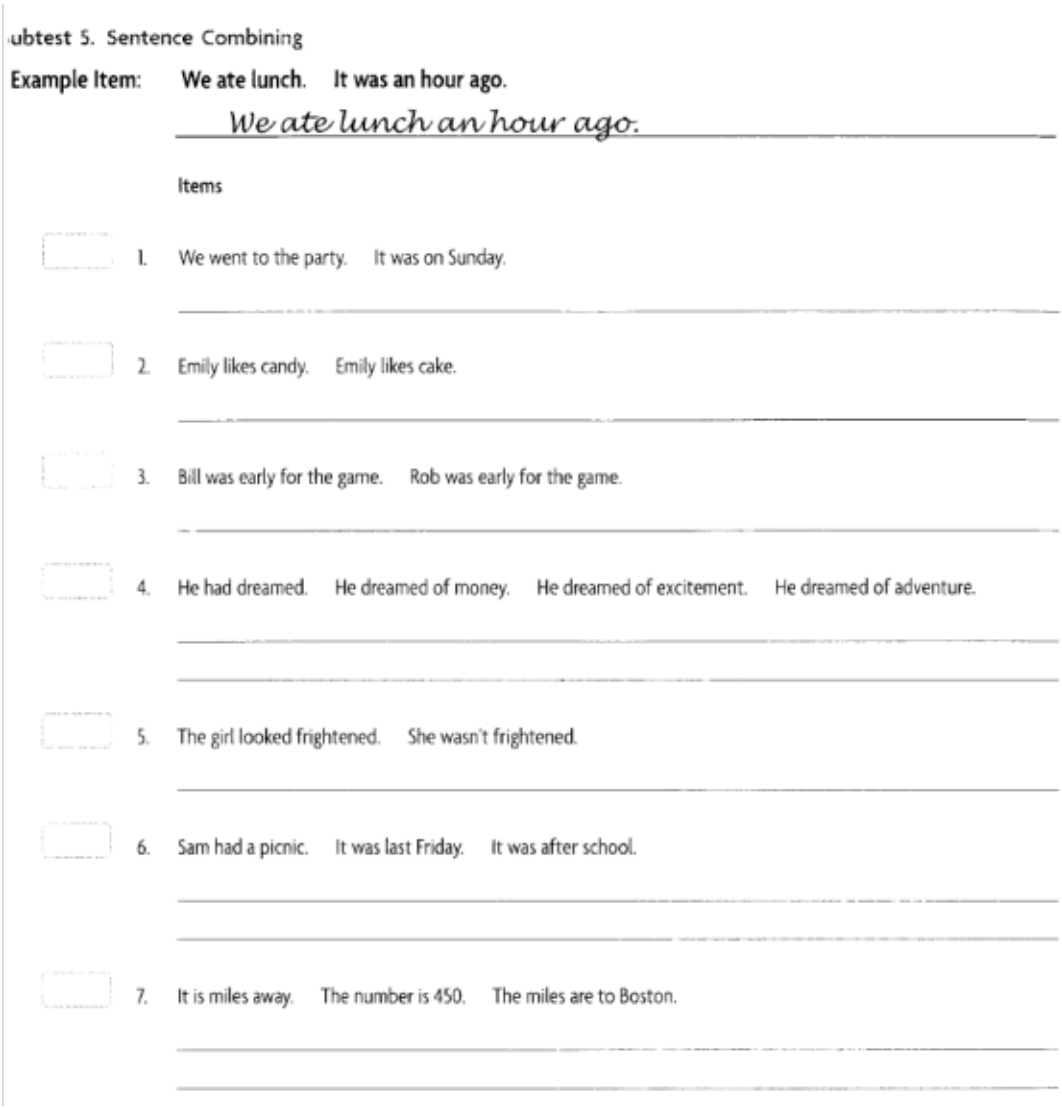
13. In the phrase "home in on the buzzing sounds," *home* means
   A. travel.
   B. house.
   C. listen.
   D. focus.
   E. join.

Appendix 28: Example of TROG-2 test

Target sentence: ‘The cup is in the box’



Appendix 29: Example of TOAL-4 test



ubtest 5. Sentence Combining

Example Item: **We ate lunch. It was an hour ago.**

We ate lunch an hour ago.

Items

1. We went to the party. It was on Sunday.

2. Emily likes candy. Emily likes cake.

3. Bill was early for the game. Rob was early for the game.

4. He had dreamed. He dreamed of money. He dreamed of excitement. He dreamed of adventure.

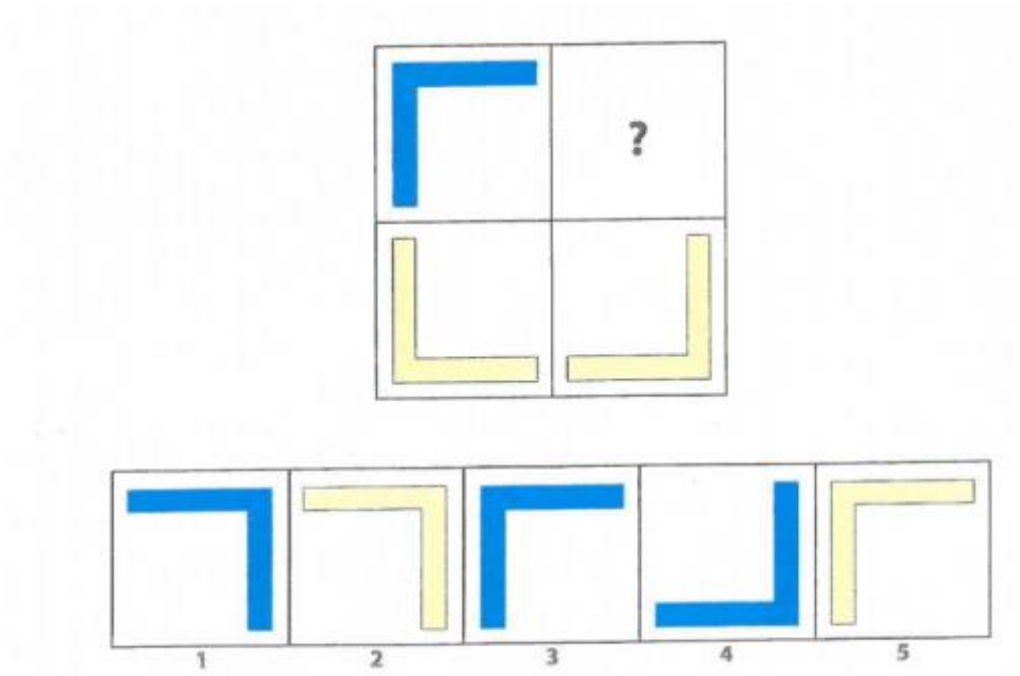
5. The girl looked frightened. She wasn't frightened.

6. Sam had a picnic. It was last Friday. It was after school.

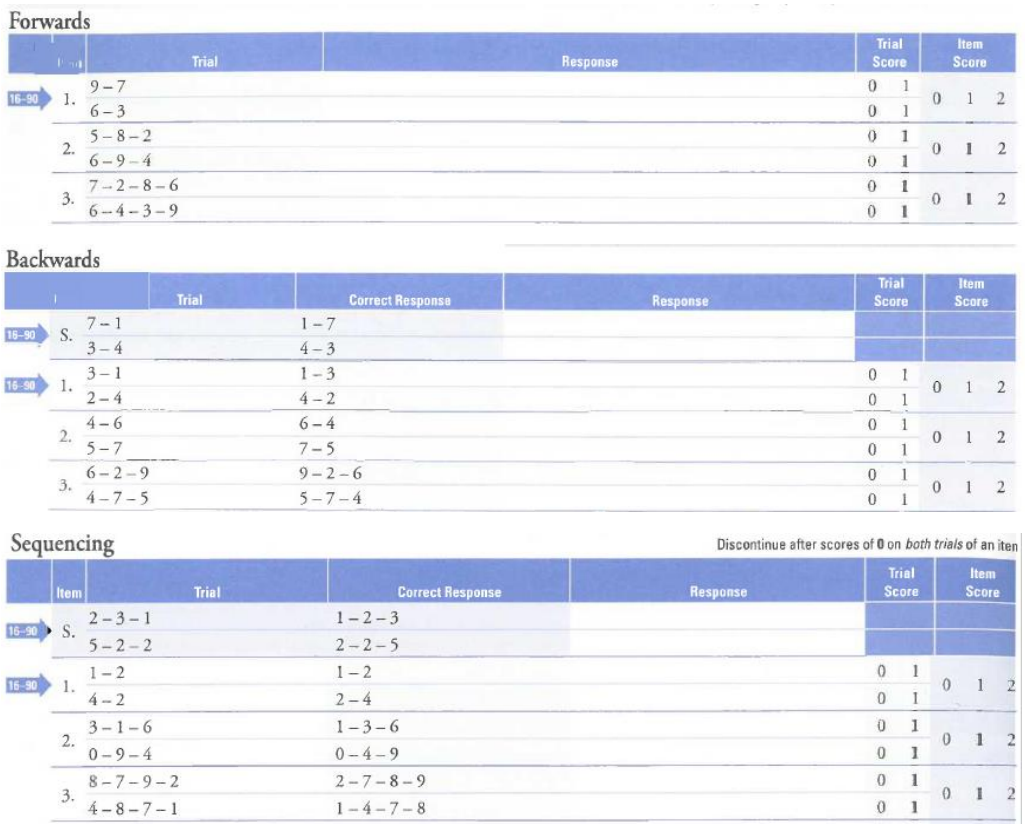
7. It is miles away. The number is 450. The miles are to Boston.

Appendices: Control Measures

Appendix 30: Example of WASI-II Matrix Reasoning Test



Appendix 31: Example Items from the WAIS-IV Working Memory Subtest – Forward Digit Span, Backward Digit Span and Sequence Digit Span



Forwards

	Trial	Response	Trial Score	Item Score
16–90 1.	9 – 7		0 1	0 1 2
	6 – 3		0 1	
2.	5 – 8 – 2		0 1	0 1 2
	6 – 9 – 4		0 1	
3.	7 – 2 – 8 – 6		0 1	0 1 2
	6 – 4 – 3 – 9		0 1	

Backwards

	Trial	Correct Response	Response	Trial Score	Item Score
16–90 S.	7 – 1	1 – 7			
	3 – 4	4 – 3			
16–90 1.	3 – 1	1 – 3		0 1	0 1 2
	2 – 4	4 – 2		0 1	
2.	4 – 6	6 – 4		0 1	0 1 2
	5 – 7	7 – 5		0 1	
3.	6 – 2 – 9	9 – 2 – 6		0 1	0 1 2
	4 – 7 – 5	5 – 7 – 4		0 1	

Sequencing

Discontinue after scores of 0 on *both trials* of an item

	Item	Trial	Correct Response	Response	Trial Score	Item Score
16–90	S.	2 – 3 – 1	1 – 2 – 3			
		5 – 2 – 2	2 – 2 – 5			
16–90	1.	1 – 2	1 – 2		0 1	0 1 2
		4 – 2	2 – 4		0 1	
	2.	3 – 1 – 6	1 – 3 – 6		0 1	0 1 2
		0 – 9 – 4	0 – 4 – 9		0 1	
	3.	8 – 7 – 9 – 2	2 – 7 – 8 – 9		0 1	0 1 2
		4 – 8 – 7 – 1	1 – 4 – 7 – 8		0 1	

Appendices: Systematised Review of Vocabulary Measures

Appendix 32: Results of a Systematised Review of Vocabulary Measures

Reference	Country	Sample size	Mean Age	Vocabulary Measure	Language Exposure Measure	Relevant findings
Arnold et al. (Experiment 2: 2018)	USA	56	University students	Shipley Institute of Living Scale: Vocabulary subtest	ART Language exposure *(self-report questionnaire measuring enjoyment, hours spent reading per week, browsing internet media, listening to audiobooks)*	Vocabulary correlated with the ART (r = .48, p<.001). The ART also correlated with the time spent reading books (r = .37, p=.005) and enjoyment of reading (r = -.61, p<.001).
Braze et al. (2007)	USA	44	16-24 years	Peabody picture vocabulary test – Revised Wechsler Abbreviated Scale of Intelligence: Vocabulary subtest	ART and MRT (Cunningham & Stanovich, 1990)	Vocabulary correlated with the ART (r = .62-.76, p<.001) and the print experience composite (r = .66-.73, p<.001).
Braze et al. (2016)	USA	295	*Mage* =20.18 (SD = 2.34)	Wechsler Abbreviated Scale of Intelligence: Vocabulary subtest Peabody picture vocabulary test – 3rd edition (PPVT-III)	ART MRT	The two vocabulary tests were highly correlated (r = .82, p<.001). WASI correlated with the ART (r = .79, p<.001) and MRT (r = .63, p<.001). PPVT correlated with ART (r = .68, p<.001) and MRT (r = .69, p<.001)
Burt & Fury (2000)	Australia	100	*Mage* =19.9 (range = 17-45)	Nelson Denny vocabulary subtest	ART	Vocabulary correlated with the ART (r = .43, p<.01).
Chiappe & Chiappe (Study 3: 2007)	USA	177	*Mage* =19.51 (SD = 2.34)	Peabody Picture Vocabulary Test – third edition	Magazine Recognition Questionnaire	Vocabulary correlated with MRT (r = .45, p<.001).

Note: Mage=Mean age; SD=standard deviation; ART=Author Recognition Test; MRT=Magazine Recognition Test

Reference	Country	Sample size	Mean Age	Vocabulary Measure	Language Exposure Measure	Relevant findings
Dabrowska (2018)	UK	90	*Mage* =38 (range = 17-65)	Vocabulary Size Test (shortened version; Nation & Beglar, 2007)	ART (Acheson, Wells, & MacDonald, 2008)	Vocabulary correlated with the ART (r = .60, p<.001).
Dabrowska (2019)	UK	90	*Mage* = 38 (SD = 16)	Vocabulary Size Test (shortened version; Nation & Beglar, 2007)	ART (Acheson, Wells, & MacDonald, 2008) Print exposure questionnaire	Vocabulary correlated with the ART (r = .60, p<.05) and the print exposure questionnaire (r=.36, p<.05).
Freed, Hamilton, & Long (2017)	USA	357	*Mage* = 18.48 (SD = .87)	Nelson-Denny: vocabulary subtest Ekstrom Battery: Extended range vocabulary and Advanced vocabulary subtests	ART (Stanovich & West, 1989) Reading Questionnaire (Scales & Rhee, 2001)	Nelson-Denny vocabulary correlated with the ART (r = .58, p<.05) and reading habits questionnaire (r = .26, p<.05). Extended range vocabulary correlated with the ART (r = .58, p<.05) and reading habits questionnaire (r = .37, p<.05). Advanced vocabulary correlated with the ART (r = .46, p<.05) and reading habits questionnaire (r = .28, p<.05).
James et al. (2018)	USA	117	*Mage* =20.94 (SD = 5.37)	Ekstrom Battery: Extended range vocabulary subtest	ART (Acheson, Wells, & MacDonald, 2008). Comparative Reading Habits questionnaire (Acheson, Wells, & MacDonald, 2008). Reading time estimates (Acheson, Wells, & MacDonald, 2008).	Vocabulary significantly correlated with the ART (r = .45, p<.001) and Comparative Reading Habits (r = .35, p<.001), but did not significantly correlate with reading time estimates (r = .10, p>.05)

Note: Mage=Mean age; SD=standard deviation; ART=Author Recognition Test; MRT=Magazine Recognition Test

Reference	Country	Sample size	Mean Age	Vocabulary Measure	Language Exposure Measure	Relevant findings
Kemper & Sumner (2001)	USA	200	Young adults: *Mage* = 22.8 (2.38)	Shipley Vocabulary test Peabody picture vocabulary test – 3rd edition WAIS-R: vocabulary subtest	*N/A*	All vocabulary measures were significantly intercorrelated (r = .61-.75, p<.05).
Landi (2010)	USA	928	*Mage* =20.17 (SD = 3.69)	Nelson-Denny reading test: vocabulary subtest	ART (Stanovich & West, 1989)	Vocabulary correlated with the ART (r = .46, p<.01).
Mar & Rain (Study 1: 2015)	UK	340	*Mage* =19.84 (SD = 3.88)	Synonym task (Mar & Rain, 2015)	Self-report reading habits (Rain & Mar, 2014) ART (Fong, Mullin, & Mar, 2013)	Vocabulary correlated with self-report fiction reading (r = .23, p<.001) but not self-report non-fiction (r = .08, p=.14). Additionally, vocabulary correlated with ART fiction (r = .32, p<.001) and ART non-fiction (r = .17, p<.01).
Martin-Chang & Gould (2008)	Canada	171	Undergraduate students	Nelson-Denny reading test: vocabulary subtest	ART (revised for Martin-Chang & Gould, 2008) Activity preference questionnaire (Stanovich et al., 1995)	The ART was used to measure primary and secondary print knowledge. Vocabulary correlated with ART (r = .55, p<.001), primary and secondary print knowledge (r = .47, p<.001; r = .32, p<.001 respectively), and activity preference to read (r = .41, p<.001).

Note: Mage=Mean age; SD=standard deviation; ART=Author Recognition Test; MRT=Magazine Recognition Test

Reference	Country	Sample size	Mean Age	Vocabulary Measure	Language Exposure Measure	Relevant findings
Milton & Treffers-Daller (2013)	UK	178	Undergraduate students	Goulden et al. (1990) test of vocabulary size	Reading habits questionnaire (*books read per year and newspapers read per week*)	No significant correlations were found between vocabulary and reading habits (r = -.03 - .17, p=ns).
Misyak & Christiansen (2012)	USA	30	*Mage* =19.9 (SD = 1.4)	Shipley Institute of Living Scale: Vocabulary subtest	ART (Stanovich & West, 1989)	Vocabulary was not significantly correlated with ART (r = .33, p<.09)
Ocal & Ehri (2017)	USA	42	*Mage* =22.7 (SD = 7.87)	- Nelson Denny reading test: vocabulary subtest - Peabody picture vocabulary test – 4th edition	ART (Acheson, Wells, & MacDonald, 2008)	Both vocabulary measures were highly intercorrelated (r = .51, p<.01). A composite vocabulary score was also created. The vocabulary composite score significantly correlated with the ART (r = .52, p<.01). The individual vocabulary tests also significantly correlated with the ART.
Osana et al. (2007)	Canada	112	*Mage* =23.7 (SD = 4.6)	Checklist and foils test of vocabulary (Freebody & Anderson, 1983)	ART SMART (*knowledge of popularised science literature*)	Vocabulary correlated with the ART (r = .66, p<.001) and SMART (r = .46, p<.001)
Stanovich & Cunningham (1992)	USA	300	Undergraduate students	Nelson-Denny reading test: vocabulary subtest Peabody picture vocabulary test	ART (Stanovich & West, 1989) MRT (Stanovich & West, 1989) Activity preference questionnaire Reading and media habits questionnaire	Vocabulary correlated with ART (r = .60, p<.01), MRT (r = .56, p<.01), activity preference questionnaire (r = .34, p<.01) and reading and media habits questionnaire (r = .23, p<.01).

Note: Mage=Mean age; SD=standard deviation; ART=Author Recognition Test; MRT=Magazine Recognition Test

Reference	Country	Sample size	Mean Age	Vocabulary Measure	Language Exposure Measure	Relevant findings
Van Dyke, Johns, & Kukona (2014)	UK	65	*Age* = 16-24 years	Peabody picture vocabulary test – Revised (PPVT-R)	ART MRT	Vocabulary correlated with ART (r = .53, p<.001) and MRT (r = .41, p<.001)

Note: Mage=Mean age; SD=standard deviation; ART=Author Recognition Test; MRT=Magazine Recognition Test