Differences in abstract and concrete word learning

A study on how the sensorimotor process facilitates abstract and concrete words

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Abstract

To what extent can you experience the word beauty through your senses? When you hear the word beauty, how does it make you feel? Is it easy or hard for you to physically interact with beauty? These were all questions asked to participants in this study to explore how our sensorimotor assists in understanding our semantic representations. This thesis aims to explore and analyse how concrete and abstract words are acquired and given representation through individual experiences. This thesis also describes what embodied cognition is and how it is already implemented in teaching and learning and how it can be further used for special needs education

The study applies a quantitative approach to the research question of how our individual sensorimotor helps to understand concrete and abstract words for primary children ages 6-9. The methods used for exploring this question focused on two components: sensorimotor ratings, valence, and body object interaction for a set of twenty words classified as concrete or abstract words. A second element of the study was to explore how language is situated through the various experiences or activities that a child engages in with their family. Parents were asked to rate different activities done at home with their children. The sample size was n=17.

The study concludes that there is no difference between concrete and abstract words on the valence rating for this particular sample of participants. In line with the research, concrete words ranked higher in the sensory experiences of sight and touch.

Keywords: sensorimotor, embodied cognition, valence, body object interaction

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Introduction

1.1 Background and purpose

How do we, as individuals, understand and create meaning in words? Language is a social endeavour, understanding the word- meaning of words is not only essential for reading but also for listening to others and understanding them (Pexman, 2020). When looking at language through a more individual lens, how do we or how have we made sense of it all? Research from Kidd et al., (2018), has looked at individual differences across linguistic systems and makes the strong argument that individual differences should be considered when examining the role of language.

Reflecting on Piaget (1952), during their sensorimotor phase, infants explore most of their environment through a range of body object interactions, such as of grasping a bottle, drinking a bottle, or moving the bottle on the floor. These actions later, evolve to more ambitious movement, namely, laying on their back, sitting, and then standing. All these important developmental milestones assist the child in furthering their exploration of their environment. Action and sensorimotor experience are still important even after infancy (Pexman, 2017), as children continue to play and active role in their environment (Vygotsky,1978) Language learning is an interactive process an opportunity for children to become social members in their environment.

Imagine a typical preschool, the children are cheerfully invited to the carpet by their teacher for a morning activity. The teacher begins by singing a classic children's song, *The wheels on the bus.* This song has many gestures and actions that correspond to a specified word, such as; *The people on the bus go* ***up*** and ***down, up*** and ***down*** (The teacher would make a hand motion of raising her hands and lowering her hands as she is getting up and going down)***,*** *The door on the bus goes* ***open*** and ***shut*** *(*The teacher might open and close her hands), *The wipers on the bus go* ***swish, swish, swish*** (The teachers motion might be having both arms swap on a side to side motion). Children mimic the gestures and even the tone of voice used by the teacher, for example, "*up"* would be said in a higher tone than when you say "*down".* In this example, we can see a glimpse of various bodily and sensory experiences, that create a multimodal view of language learning.

All these actions from exploring different objects in infancy to learning the language in the social construct of gestures, movement, social experience, and feedback from peers and

teachers help in shaping our mental lexicon. According to the APA Dictionary of Psychology, the mental lexicon is the words that a person uses or is able to recognise when used by others (2022).

The present work builds on previous literature and research that has explored the multimodal model of semantic richness and language processing. *Semantic richness* (Pexman et al., 2013) is a term that describes the different semantic information a word might have. Thereby words that have a richer semantic representation are recognized faster (Pexman, 2012). This would mean that words that have been experienced earlier in life are retrieved quicker than those that are more abstract.

A multimodal approach means that words can be learned through various inputs, such as sensory, motor, emotion, or social (Reggin et al., 2017). This form of approach can help explain why there are differences in semantic processing for individuals since meaning is constructed through context and experiences (Pexman & Yap, 2018). As with the previous preschool example, words are explored through motion, and it is a social interaction between the children and teacher and between the children themselves. The meaning of words is represented through the multimodal approach where stimulation is still processed even though there is a lack of both sensory and perceptual insight (Borghi et al., 2019).

The novelty of this research was not only that this was not constricted by exploring only one dimension of semantic knowledge but on three different dimensions that can help to further understand individual semantic processing. Vigliocco et al. (2009) states that understanding the meaning of words, either concrete or abstract, are grounded in an individual's interactions and experiences in the environment. This is in line with the current research done by Murgiano et al., (2021), on how language learning is situated in the physical and communicative context (p. 8). This is particularly important due to the nature of how our culture and personal experiences are also situated in both the physical environment and the communicative context. The thesis investigated and explored the relationship between the individual's environment and their semantic representation of concrete and abstract words through sensorimotor.

1.2 Structure of the thesis

The thesis has been divided into four main parts. In Chapter 1 (the current chapter), background information for the topic of choice is discussed. This chapter includes the aims and research question for the study and its importance for teaching. A theoretical framework

which includes literature that further explains different elements of the sensorimotor process is also presented in this chapter. The literature includes theories on concrete and abstract words, sensory experience, body object interactions, and embodied cognition. The chapter also includes examples of how the theoretical framework is implemented in various subject areas in the classroom. The chapter concludes with the research question and hypotheses that will be explored and investigated for this thesis.

Chapter 2 features the methodology, such as the study design and the methods for collecting data. The chapter also discusses how data was collected and how the participants were recruited. Additionally, the chapter explains the materials that were created and used for the tasks. The chapter also discusses the types of analysis conducted to further explore both the research question and hypotheses.

The results from the data collection are presented in Chapter 3. The chapter begins by introducing descriptive statistics from the sample group. The next section presents the results from the sensorimotor tasks that correlated with the proposed hypotheses for the study. Correlation analysis for the explored variables is also conducted in this chapter. Chapter 3 is divided into three subheadings that highlight the hypotheses that are being analysed.

Discussion and reflection for further studies are covered in Chapter 4. In the final chapter, a summary and interpretation of the results are discussed as well as the limitations encountered in this thesis. In concluding the chapter, a reflection on practical studies can be followed to further facilitate a clearer overall picture of the factors that influence individual differences.

1.3 Theoretical Background

1.3.1. Embodied cognition

Grounded cognition proposes that cognition is grounded in sensory and motor functions, which is divorced from the traditional perspective that cognition is amodal (Barsalou, 2008). The amodal model postulated that the mind and the body work as two separate entities and there was no reliance on each other. Evidence of embodiment also comes from studies that demonstrate that when a person is asked about a word, they are often able to imagine the function of that word (Fugate et al., 2019). This further supports grounded or embodied cognition states that the environment, situations, and the body, are all interwoven and represented in cognition (Barsalou, 2010). Often, grounded cognition is referred to as

embodied cognition and it has many implications on how we understand different concepts via our sensorimotor stimulation.

Barsalou (2010) has strongly criticised this newer reference because it only focused on one domain of cognition, the body (p. 2). Both, grounded cognition, and embodied cognition have influenced the field of cognition and sensorimotor systems (Pexman, 2019).

Most embodied theories, focus on a multimodal approach to cognition, this includes the motor, sensory, emotions, perception, and language systems (Pexman, 2019). Prior research looked at embodied cognition in the context of learning nouns through the sensorimotor functions, research suggested that when a child engages in active exploration of the environment and can manipulate different objects there is an increase in semantic features that relate to helping the child differentiate objects easily (Scofield et al, 2009). However, it is important to state that embodied learning better experiences when there is a direct link between sensorimotor and the information that is being learnt (Wellsby & Pexman, 2014). Simply adding movement for the sake of it, does not equate to embodied learning, this will be further discussed further into this chapter.

1.3.2. Semantic knowledge

According to the APA Dictionary of Psychology (2022), semantics is the study of the meaning of words. As part of this study, the focus is on two themes of words, which are abstract and concrete. Our mental imagery, which is what is created in our perception is stimulated in the absence of a stimulus (the physical object). When we visualize items that are not present, our senses and semantic properties are activated. For example, when we hear the word *kick* or *jump,* our mental representation and semantic representation work together to help us visualize the actual motor movement of these words (Muraki & Pexman, 2021). Muraki & Pexman (2021) highlighted that while mental imagery can engage several sensory experiences, the main two that are associated with mental imagery are visual and motor.

Language processes are an individual endeavour because not all experiences are perceived equally or understood differently. When we recall facts, vocabulary for different objects, or general facts that provide us with a reference. Our experiences however differ from individual to individual. When describing language as situated, there is an acknowledgement that language is a face-to-face interaction that embodies a combination of gestures or signs of speech that can all assist in conveying meaning (Murgiano et al., p. 5).

Language is also explored within the constructs of our environment and experiences, for example, a child that plays the computer game *Minecraft* with their peers or with their parents might acquire semantic knowledge on the tools used while playing the game, such as; a pickaxe, a shovel, a plough. All these tools are concrete in their descriptions and the child is engaging in how these tools are used by viewing the onscreen character, chop the tree, shovel the sand, and plough the dirt so they can plant seeds. Our semantic representation is exposed daily in different contexts, face to face interactions at home or school, to video games, and all of these experiences assist in increasing semantic knowledge.

1.4 Embodied learning

How does embodied cognition translate to learning? Fugate et al., (2019), conveyed that when the information is introduced for the first time, engagement of both the sensory and motor cortices, provides a richer stimulation occurs which in turn leads to a better recall and understanding of the material (p. 279). Therefore, embodied cognition is an extension of embodied learning in the classroom, it is a strategy that can help highlight learning for children. We can explore different areas in teaching and learning where embodied learning has been explored.

1.4.1 Science and Technology

Look at the program STEAM (Science, technology, engineering, arts, and math), which is widely used in some schools. In classroom settings, STEAM is used to introduce and provide a hands-on experience by combining different subject areas. If we took a moment to visualize a typical science lesson in the primary grades (Years 1-5), a teacher might want to introduce certain scientific topics to the class, for example, the states of matter. Here the question to bear is, will the children learn more by simply reading and listening to the teacher discuss the topic or will they learn more through *active* engagement by creating, watching videos, describing the topic using the senses, or experiments? The educational implications of the physical experience can positively influence a student's learning (Shapiro & Stoltz, 2019).

An example of where embodied learning intertwines with various school subjects together such as, science, technology, and language was by the study conducted by Gómez et al., (2021). The goal of this study was to examine how action while reading could enhance the vocabulary and comprehension of a scientific topic. The programme that was used in this study was an application called EMBRACE. The students were placed into four groups. In one group the children read and used the iPad to simulate the action of the sentence. The

second group only read the text and did not simulate any of the action. The third group listened to the researcher read aloud the text and copied the researchers' actions when simulating the vocabulary in the text. The final group had the researcher read aloud the text but no action was followed. The findings in this study suggested that the group that read the text and simulated the action that corresponded with the vocabulary had better comprehension (Gómez et al., 2021). The findings suggest positive results when the curriculum and classroom teaching model the embodied principles of making meaningful connections with context and movement.

1.4.2 Mathematics

Embodied learning is also present in mathematics, a study from Peppler (2017) describes that counting is something that is done using objects from the real world. We count things by observing them, and this is very true especially when student are beginning to explore the one-to-one correspondence of numeracy and object, such as 1 spoon, 2 spoons, etc. Peppler (2017) explains that we do not visualize abstract things but rather concrete things. This is a strategy that can be seen in schools when young students use manipulatives while performing basic mathematical concepts such as addition, subtraction, division, and multiplication. In schools, students might be using blocks or counters to bring together a certain amount, moving objects into equal groups to begin the understanding of division, and physically taking away a certain number of objects. Later the student move to a more abstract symbol representation of such mathematical concepts, such as, 4+ 5= , 6-4=, etc.

According to Fyfe et al., (2019) refers to this as *concrete fading*, which is the use of multiple representations of a concept that moves from concrete to more abstract (p. 404), such as using real objects for counting, then using pictures, and finally just the numerical symbol. Thereby establishing learning by grounding meaning first through physical interactions or manipulation of objects and then progressing to more abstract symbolic representations. This is especially important for students that need interventions in mathematics, and embodied learning with first grounding the concepts through the use of manipulatives and movement before gradually moving to a pictorial representation and then more abstract symbols would seem like a more appropriate approach to teaching and learning.

1.5 Sensorimotor Experiences

1.5.1 Abstract and Concrete words

Concrete and abstract words have been subject to a lot of debate within the lens of embodied cognition, as pointed out by Borghi et al. (2017) that while abstract words cannot be as easily perceived through the sensorimotor, abstract words are still grounded. Abstract words, according to Borghi et al., (2017), abstract words are less constant when people are defining different abstract words or when people are asked to produce associations. Concrete words however are categorized into broad categories of objects and artefacts (Borghi et al., 2017, p. 264). Embodied theories are easier to explain when discussing concrete words because it is grounded in sensorimotor information (Pexman & Yap, 2018), while abstract words do not rely on the sensorimotor experience (Reggin et al., 2021).

Concrete words are more tangible than abstract words, thinking of the word *hammer*, one can visualize the motion, through the senses it is tactile, it is visual, and you can hear it when it makes an impact with a surface, but the word *justice* might be less dependent on the senses or grasp ability. One might be able to see justice but that within itself is subjective, so perhaps *justice,* which is an abstract word is better understood through emotion(valence) or experience. Since concrete words are grounded in sensorimotor processes, these words are recognized faster in naming and recall tasks (Borghi et al., 2017).

One of the main discussion points on concrete and abstract words is that there are two opposing viewpoints, on one hand, concrete and abstract words are not different, and on the other hand, concrete and abstract words differ (Borghi et al., 2017). Understanding concepts that are beyond the physical experience can be a complex endeavour. Yet, abstract words help children to classify experiences or convey meaning or ideas, helps in developing abstract reasoning skills, and communicate with increased scope greater than just the here and now, such as when we talk about *justice or anger.* Therefore, it is important to study and research how abstract words are developed in children.

From a developmental standpoint, understanding that abstract words are more grounded in emotions, especially during the earlier stages of a child's language development provided insight on how educators can take this opportunity to provide emotional associations to abstract words. In this thesis, we seek to investigate differences in concrete and abstract words through semantic properties in primary children.

1.5.2 Sensory Experience Rating

Sensory experience rating (SER) measures the extent to which a word referent stimulates the sensory or perceptual experience in the mind of the reader (Juhaz & Yap, 2013). SER is the measurement of a semantic variable that is subjective (Juhaz & Yap, 2013). Participants' responses are individualized and depend on how the word is perceived through their mental imagery, which is based on imageability. *Imageability* refers to the ease of recognizing words that create a mental image (Juhaz & Yap, 2013, p. 161). In an SER task, participants are asked to "judge" the degree to which they can experience a word through smell, taste, sound, touch, or sight.

However, there is a possibility that these degrees are individualized and have more variation depending on the age of the participants. Most of the data collected for SER is based solely on adult responses, which could pose a possible deficit when using the rating scales on children, as adults and children have varying experiences with certain word referents. This is like the problem with body object interaction (BOI – see 1.5.4), an adult might be more likely to interact with an *axe* than a small child has had. While the child might have seen an axe or touched the handle of the *axe*, their action and perception are limited because an *axe* is most likely not the safest object for a child to be handling.

An interesting aspect of utilizing SER is how is it useful in examining positive and negative words (Juhaz & Yap, 2013). Words that are rated positively or negatively produce sensory stimulation for the reader. In the following section, we will discuss the emotional component

1.5.3 Valence

For children, emotions play an important role in daily development and interaction with their environments. Emotion vocabulary development in children is said to be acquired in developmental steps (Grosse et al., 2021), this is important as young children experience negative and positive emotions separate (Nook et al., 2017). Vocabulary development evolves from either positive or negative experience into a more multi- emotional experience, which may be the reason children at a young age put emphasis on valence for them to begin understanding their own emotions (Nook et al., 2017, p. 881). Another important aspect of emotional vocabulary development is the interaction the child has with their parents (Shablack et al., 2020). At an early age, parents are inferring and name the emotion their child exhibits, therefore scaffolding the child's understanding and semantic representation of emotions. At this early age, parents are helping to develop their child's emotional vocabulary.

Emotions in embodied cognition studies are categorized into two different compartments, valence, and arousal. While arousal has been measured in different research (Ponari et al., 2016; Pexman & Yap, 2018). Research from Borghi et al. (2017), and Kousta et al. (2011), postulated that abstract words are grounded in experiences and emotions.

One hypothesis used to differentiate between concrete and abstract words is the *Affective Embodied Account* (Kousta et al., 2011; Borghi et al., 2017). In this hypothesis, emotions are an important component in attaching meaning to abstract words than it is for concrete words.

In contrast to having abstract words grounded in emotions, Yao et al., (2018), proposed a *"multimodal induction"* (p. 4) which states that concrete words are more grounded on emotions. In other words, concrete words are more grounded in emotions because emotions are easily activated through the sensorimotor experience, which is more relevant for concrete words. This is in support that concrete words are more tangible and therefore evoke more sensory experience than abstract words.

Another way to view how abstract words are learned is by thinking of them as *essential placeholders* (Lindquist et al., 2015) which marks the felt experience that the individual felt. This is marked as well by the dyad between the caregiver and the child. A concept such as *love* is difficult to explain to a three-year-old, but the bodily experience of begin hugged, hearing the caregiver say *"I love you",* and the act of being cuddled or kissed are all experiences felt that help young children create the *essence placeholder* that is linked to bodily experiences. As the child grows and continues to that will later help create semantic representations of other words that refer to *love,* such as; *happiness, joy, and warmth.* This corresponds to the *affective embodied account* discussed in the section of abstract and concrete words, as it explains how emotions and experiences are connected to the development of abstract words.

For this thesis, the focus was on valence, which is the degree to which a word is either positive or negative (Kuperman et al., 2014). Valence also influences the rate at which words are processed, in other words, words that ignite a negative effect tend to be processed slower than those that represent or display positive feelings. Valence plays a central role in helping to understand the development of concrete and abstract words, on one hand, there is the *affective embodied account* (Kousta et al., 2011; Borghi et al., 2017), which favours abstract words being grounded in emotions and on the other hand we have the *multimodal induction* (Yao et al., 2018), which proposed that emotions are more grounded in concrete words.

1.5.4 Body Object Interaction

Another semantic variable that is used to investigate the role of the sensorimotor functions is body object interaction (BOI). This is a variable that measures how easily the human body can interact with a word's referent (Siakaluk et al., 2008, Pexman et al., 2018). The response rate in BOI is quicker for words that are rated high in BOI, such as *brush, spoon,* and *chair,* because of the word's *graspability* (Pexman, et al., 2019) and it also leads to more activation in our semantic knowledge (Thill & Twomey, 2016). Words that would be rated lower on the BOI scale, such as *moon, cloud,* and *unicorn,* which are less easy to grasp. A study by Heard et al., (2018) examined BOI across seven different measures to identify which semantic dimension was strongly related to BOI ratings. The study's findings concluded that the semantic dimension of *graspability* was a significant predictor for high-BOI words (Heard et al., 2018, p. 8). When thinking of g*raspability*, one might be thinking mostly about the usage of the arms and the hands, but there are other limbs that can also be included when thinking about BOI ratings, such as the feet and legs (Heard et al., 2018).

BOI effects in research have yielded different findings assuming that BOI is semantically richer because of its strong sensorimotor experiences (Pexman et al., 2018). BOI has also been investigated in relation to the age of acquisition (AoA) (Thill & Twomey, 2016). AoA focuses on marking words based on the age that which the word is learned. The results of the study concluded that BOI was not predicted by AoA. However, the study acknowledged the need to create new measures that provide an internal sensorimotor experience (Thill & Twomey, 2016, p. 6).

One limitation of the BOI semantic variable is its limited rating of words (Pexman et al., 2018). A larger set of BOI ratings would be beneficial to continue to explore the relationship between BOI and other semantic variables (Pexman et al., 2018). There is also a limitation on the lack of child-centred BOI ratings of different words. While BOI has resulted in language processes (Pexman et al., 2018), it is still necessary to provide further development in the understanding of sensorimotor experiences and processes.

1.6 Individual Differences

While most of the research on sensorimotor tends to be explored by undergraduates and adults, there is still a gap in research that is solely focused on the child. Likewise, individual differences are not the focus of cognitive processes or performance (Muraki & Pexman, 2021,

p.3). One aspect that also determines individual differences is the influence of culture. Cultural norms, language and the experiences of individual shapes information that is perceived and understood by an individual (Fugate et al., 2019). Therefore, when looking at differences, it is important to consider that embodied learning is flexible because there are many different factors that shape an individual. A broader lens is needed in order to further cast a light on individual differences and how to create opportunities that further promote the embodied principles of action. The classroom is a highly dynamic environment with many individuals and children arrive to school with their own interpretations of the world through experiences, and therefore, using the sensorimotor process as a proxy in the class.

1.6.1. Situated Action Cycle

Research by Barsalou (2020), on what he called the Situated Action Cycle which accounts for relations between perception, cognition, and actions and also included other domains such as the environment, affect, and outcomes (p. 3), allows for a more whole package understanding on individual differences which cannot be solely viewed through one lens but by looking at different domains, such as an individual's socioeconomics, the social and cultural environment, the range of different emotions experienced by individuals to name a few. All these domains create a whole image of individual differences and how the mind and body evolved as a consequence (Barsalou, 2020). This is particularly important, as it adds to the field of grounded cognition that extends beyond actions and perceptions and it bestows the field of ground cognition the opportunities to explore more social and cultural issues.

Barsalou (2020) contends that the separation that is made in regards to concrete and abstract words, is relatively unnecessary because abstract words are defined as negative or not concrete, which in turn offers no insight into its semantics (p. 10). Pexman (2019) further supports this claim by stating that while linguistic experiences are important for abstract words, it is not the only domain in which it is grounded on.

One of the gaps found in the current research is data on these different domains that have an impact on an individual's language process, such as socioeconomics or the social environment because the extent to which we experience our environment differs from individual to individual.

1.7 Aims and Research Question

This thesis aims to develop current understanding of the factors that contribute to semantic differences across children in primary grades and explore how personal experience and interactions shape our semantic process. The main question that the thesis will be exploring is:

How does our individual sensorimotor process affect our understanding of concrete and abstract words in primary children ages 5-9?

To explore how sensorimotor affects concrete and abstract words, two hypotheses will be used to help explore the main research question, the hypotheses are as follows:

Hypothesis 1: Concrete and abstract words are grounded differently with concrete words depending more on sensory experience and abstract words depending on emotion.

Prediction: Emotional ratings for abstract words are higher than those of concrete words

Hypothesis 2: The degree to which our sensory experience interacts with the environment affects the semantic representation of abstract and concrete words

Prediction: There is a positive correlation between the sensorimotor process and the types of activities undertaken by children.

Various tasks were developed and used as a proxy to measure the differences in sensorimotor processes.

1.8 The importance of the research

Further research in developing a proper psychometric measure to further explain and expand on how individuals process language. Individual differences are not considered in language processing. Rather, differences are often classed as failures or flaws (Kidd et al., 2018). These so-called errors assist in identifying individual differences that may relate to language and may signify how semantics develops on an individualized level. Putting this theory into action could allow for the creation of an updated and tailored intervention plan for students. In this way, errors could be viewed as an indication of the extent of that individual's experience and understanding of the word.

Adams (2016) stated that when examining the role of embodiment as an intervention for specific language impairments, it may be beneficial for the students to ensure that movement and action be included. This suggestion for the increase of motor action in language learning was also proposed by Glenberg (2011) through the *Moved by Reading* intervention which focused on reading comprehension using both physical and mental stimulation of a sentence. Participants in that study read a sentence and manipulated toys to perform the action or simulation that corresponded with the sentence and on the second attempt, participants did not have the toys to manipulate and instead relied on visualizing the action for that sentence. Glenberg (2011) states that "language is understood by stimulating the situation described by the language" (p. 6). This example of intervention demonstrates the different layers that embodied cognition can be utilized in education.

Whilst it is stated that relying on physical manipulation is not practical, the more children practise acting out sentences the easier it is for the child to perhaps move towards an *image manipulation* (Glenberg, 2011) which transforms the words into symbols that represent the object. The work done by Glenberg (2011) further solidifies the support for a multimodal approach to reading remediation for students with learning disabilities (Fugate et al., 2019, p.278). The finding from Glenberg (2011) supports the importance of remedial intervention in a multimodal approach that can be effective for students with learning disabilities.

Investigating how individual differences in the sensorimotor processing of words might assist in the development of individualized teaching plans for various children, both for the typically developed but also those that need assistance in both second language learning and dyslexia. Continuing to examine word associations across multiple domains can help develop and evolve a better understanding of vocabulary acquisition and how word knowledge is represented both in context and individually (Reggin et al., 2017). The importance of the research is more focused on language but as previously stated at the beginning of the chapter, embodiment learning and teaching are good practice measures that ensure success in students, especially early learners who may rely more on physical movement and concrete manipulation.

In all types of classroom settings, embodied learning is a potentially useful tool for educators, but it is also important to note that not all learning needs to be embodied. In fact, varied approaches are needed as children are individuals which as an educator, is important to keep in mind.

1.9 Summary

Semantic representation is dynamic as it is based on an individual's experiences, and these different experiences provided in the opening chapter of this paper. Further, our semantic representation changes as we grow and begin to experience new ideas and explore our environment. To explore individual differences between concrete and abstract words, several tasks have been created to test the hypotheses on how concrete and abstract words are grounded differently and how the environment affects our semantic representation of these words. In the following chapter, the tasks created for this thesis and the procedure will be properly introduced.

Materials and methods

2.1. Methodology

The following chapter focuses on the methods and methodology used to collect data. In this chapter, we will discuss the study design as well as the rating scales created for the study. The primary source for the thesis is the data collected from the four different tasks that the participants completed. The different tasks were created and executed to identify how the sensorimotor system affects the understanding of concrete and abstract words. Tasks were created by the researcher and were pilot tested before formally being presented to the participants.

This chapter has been divided into six sub-chapters that highlight the study design, the sample and data collection, development of word referents, development of tasks, pilot testing, and procedure. The final section of this chapter will discuss the data analysis that was conducted for this research.

2.2. Study Design

2.2.1. Exploratory Design

An exploratory framework was done for this study to identify and investigate frequencies and characteristics of individuals' differences in the sensorimotor process for the properties of words. Exploratory research is risky and not forthcoming in what the results will be or if any will be answered at the end of the study (Swedberg, 2020). This type of study design is important as it helps to ignite the forward momentum in the field. The thesis aims to explore the individual differences in the sensorimotor process that affect our understanding of concrete and abstract words. According to Swedberg (2020), exploratory research explores an existing topic to produce new ideas or hypotheses (p. 16). Examining the factors for individual differences in abstract and concrete words

2.2.2 Rating Scales

Likert scales were used to collect data on some semantic variables for the thesis. The Likert scale represents the participant' subjective responses to different variables on sensorimotor. A characteristic of Likert Scales is a balance of positive and negative items that are generally used to dimmish response bias (Willits et al., 2016, p. 127) and participants and

enable the participant to indicate their feelings towards the items. Data collected needed to be quantitative on an interval scale which allowed the data to go through statistical analysis to explore the research question and hypotheses.

2.3 Sample and data collection

Before the data collection, a notification form was created and sent to the Norwegian Center for research (NSD). The form was processed and accepted on January 25, 2022, and complied with data protection legislation. Sampling for this study was focused on primary school children from Year 1 to Year 3,

For this thesis, only schools whose main teaching language is English were contacted, therefore International Schools in the Viken and Oslo area were recruited. Schools were reached out either by a phone call or a letter requesting to conduct research (Appendix A) in early February 2022. The letter highlighted the aims of the study along with what implications it would mean for the school. Once the principals of the schools agreed and gave their consent for research to take place in their schools, the researcher contacted the head of the primary year's department in each school in order to begin to set dates and times for the visitation and also address any requirements that needed to be provided, such as the Wi-Fi access, and specification for equipment if there were any. The researcher created a schedule of the days and times the participants would be taken out of the classroom for the tasks. When the schedule was approved, an introductory email was sent to the classroom teachers with information on the aims of the research and the time and days the research will be visiting.

Information about the research and consent from the parents was obtained via Nettskjema (2022), which is a platform created and used at the University of Oslo. The email with the information was sent either by the principal of the school or by the head of primary years. A total of 17 participants ranging from ages 6 to 8 were recruited. There were four participants from Year 1, seven participants from Year 2, and eight participants from Year 3. Data collection for this research began in March 2022 and took three to four days of school visitation for each school. In April, the researcher contacted one of the schools again in the hopes of recruiting more participants. There was one new participant that was recruited at that time.

Before the analysis of the data, two participants were excluded from the studies, because one had an assistant and the other participant had obsessive behaviour that made it difficult to follow instructions. Participants were able to choose a prize after the completion of tasks.

2.4 Development of words for the study

A list of 20 words, 10 concrete and 10 abstract words, were selected from an existing database (Kuperman et al., 2012; Brysbaert et al., 2014). The words in the research conducted by Brybasert et. al (2014), were rated from 1 to 5 based on the level of concreteness. Words that are easier to experience through the senses were rated higher in concreteness, such as *lemon* and *fish* as compared to words that were more abstract such as; *dream* and *peace* (Brysbaert et al., 2014). Following the study conducted by Ponari et. al (2016), the categorization of the 20 individual words followed the criteria for labelling concreteness of a word higher or equal to 3, and abstract words were rated below 3 (see Table 1). To ensure that participants knew the words, we used the word age-of-acquisition variable: the criteria for words chosen were set to be below 6.5 years.

Table 1 shows the list of 20 words (*Items)* that were used. The items are the abstract or concrete words at were used. *Concreteness* rating is how the words' meaning can be understood through action and perception (Brybaert et al., 2014), *Subtlex* refers to the word frequency, and AoA is in reference to the *age of acquisition* which is the average age in which a word is learned (Kuperman et al., 2012). These three categories were thoroughly examined when looking for which words would make the finalized list. The beginning example of the list of words before the final edits have been added to the Appendix (see Appendix C)

Table 1:

List of words used for the research

Item	Concretness	Subtlex	AoA	Item	Concretness	Subtlex	AoA
Music	4.31	7734	3.81	Peace	1.62	3550	6.32
Thunder	4.34	679	4.89	Sadness	1.82	244	4.78
Couch	4.71	1197	3.74	Love	2.07	56864	5.17
Garden	4.73	1354	5.33	Friendship	2.39	1164	5.62
Tower	4.76	1165	6.33	Think	2.41	137261	4.76
Forest	4.76	963	6.28	Fear	2.57	3523	4.79
Ambulance	4.81	1143	6.16	Happiness	2.6	1249	6.17
Tent	4.96	892	5.16	Dream	2.6	6798	4.88
Fish	5	4258	4.05	Danger	2.68	2227	4.61
Lemon	5	613	4.74	Beauty	2.93	2460	5.05

2.5 Development of tasks

Develop of tasks followed some aspects of other research done in the field of embodied cognition. The objective of the thesis was to explore individual differences in abstract and concrete words for children ages 6-8 and the participants needed to know the words being presented.

2.5.1 Parent Survey

To examine if the participant's home experiences related to their semantic knowledge and representation of concrete and abstract words questionnaire was created (see Appendix D). Parents filled out information on the home language and reading language. Additionally, parents rated different activities that are enjoyed as a whole family unit. Four main categories were created: Outdoor Activities, Cultural Activities, Leisure Activities, and Home-based Activities with each category having four to five examples.

Each category had sub-activities that were used for the ratings. For Outdoor Activities, parents rated the following activities: hiking, swimming, cycling, cross country alpine, gardening, sailing, camping, and others. For Cultural Activities the following activities were rated: visiting a museum, attending a food festival, attending a music festival, visiting a historical site, attending the ballet, attending the opera, other. Activities rated for the category Leisure were as follows: visiting the library, going to the movies, playing an instrument, listening to music, meditating, painting, taking a stroll in the city, grilling outside, and other.

Lastly, activities rated for the Home-Based category were as follows: arts and crafts, baking and cooking together, watching a movie, playing video games, playing board games, conducting science experiments, and other.

The variables for the different activities were created on a Likert Scale with five options: *never* (1)*, rarely* (2)*, sometimes* (3)*, moderate* (4)*, a great deal* (5), and *others*.

2.5.2 Sensory Experience Rating Task

The task was designed to evaluate the extent to which a word- referent is experienced with the senses. The method for constructing the sensory experience rating was presented on a Likert scale rating of 1-5 which measured as follows: *never, a little, sometimes, often, and greatly* (see Appendix F). The reason to have a scale for each of the five senses was to gather data on the extent a word could be experienced through the five senses.

The task was implemented on Nettskjema (2022) and divided into two forms each containing ten words. The reason the task was divided was simply to ensure the participant had a break and did not feel overwhelmed by the task.

Valence was used to collect data about the emotional experience associated with word-referents. was also examined in the task and was measured on a 5- point liner scale. The measurements for the scale were as follows: 1- *very negative, upset, sad,* 2- *upset and sad*, 3- *neutral, I do not feel good or bad*, 4- *positive and happy*, 5- *very positive and happy.* The scale had two extreme ratings and the middle was the neutral point for the word. To add more clarity to the scale, an emoji face was added to demonstrate the various feelings (see Appendix F).

2.5.3 Body Object Interaction

To examine if there were differences between how individuals interacted with words, participants were asked to rate the 20 words on a Likert scale that measured how easy or difficult it was to physically interact with the word referent (see Appendix G). Reviewing the research from Pexman et al. (2018), and the use of the 7-point Likert Scale to measure body object interaction but because of the age of the participants, a 5-point Likert Scale was more feasible. Additionally, this research did not add *"I do not know this word"* which was an option in the research from Pexman et al. (2018), the reason for the omission was that the

words were selected for this thesis were based on the age of acquisition (AoA) with the highest AoA being 6.3.

The measurement scale was as follows: 1- *it is very hard to do things*, 2- *it is hard to do things*, 3-*it is OK to do things*, 4- *it is easy to do things,* 5- *it is very easy to do things*. The task was divided into two parts, like the sensory experience rating task.

2.5.4 Free Association Task

This task was used to measure how much participants' semantic representation is both on an individual and group level. As with the previous tasks, the words were divided into two sets of 10 words. This audio task was recorded using the *University Dikafon* (2022). Participants were given examples of what they will be doing for this task. The research began the task by stating, *"Today, we are going to play a word game. We are going to think of all the words that might connect with our main word. Let's practice first before we begin."* Once the participant understood the directions of the task, audio recording began. Only the first words were used to represent the participant's semantic representation. Initially, the 10-second timer was going to be used but it was observed that this caused some stress in participants, and the decision was made to withdraw the timer. If the participant did not have any more words to contribute, they would simply say, "that's all", and the researcher would move to the next word.

While the Free Association Task was conducted and the data was collected, data from this task were not analysed for this thesis

2.6 Pilot testing on tasks

Before data collection occurred, all tasks were trialled. This allowed the researcher to make modifications and adjustments to the word stimuli, how the questions were phrased, and overall ease of completing the tasks. Additionally, the amount of time it took the volunteer to complete the task was also a deciding factor on how best to structure all tasks to suit the age of the participants. At the beginning of development, one task was not only taking fifteen minutes to complete but the participant was confused about what should be done. This amount of time and confusion was not ideal for participants. Therefore, the tasks were redone in a way that was more child friendly, with clear and direct language, examples of what the participant had to do, and modifications to the original words used. Once modifications were

completed, it was trialled again with the same volunteer and the tasks were completed with less ambiguity on what to do and the time was shorter.

The volunteer for the pilot testing is a student in Year 2 which would be within the age range that the tasks were created. The parent survey was sent out to three individuals who were not participating in the research. There were two reasons why the parent survey was piloted, firstly, it was important to check that the link for the consent and the parental survey worked, and secondly, the researcher asked the volunteers to check if the survey made sense and to check the length of time it would take to complete.

2.7 Procedure

Participants were tested individually in a room allocated by the school. Three tasks were conducted which included a free association task, a sensory experience task, and a body object interaction task. The sensory experience and body object tasks were conducted on a laptop utilizing the platform *Nettskjema* (2022) which was created and used by the University of Oslo. The free-associative task used the software Diktafon (2022) from the University of Oslo. All tasks were stored in the sensitive data platform known as TSD which was developed by the University of Oslo. The body object tasks were completed first, followed by the sensory experience rating, and finalized with the free association task. The researcher read aloud each question from the sensory experience task and the body object task to each participant. The participant then used the computer mouse to click on their response. The tasks were conducted on different days and the length of the tasks varied with each participant.

Before beginning each task, the research introduced what the task was measuring and instructions on the task (see Appendix E). The words used as examples were: *Bed* and *Anger*. These two words were chosen as examples because of their concreteness rating. Brysbaert et al., (2014) database identifies *Bed* with a concreteness rating of 5, while *Anger* has a concreteness of 2.41. These examples demonstrated the two constructs that were being measured, abstract and concrete words, and were a good introduction to what the participants would be experiencing (Appendix A). Once instructions were given, the researcher asked the participants if they understood what they would do. The researcher read aloud all the questions to the participants and the participant used a mouse to click on their answers.

Sensory experience rating required the participants to know the five senses, therefore, before the task began the research asked the participants if they knew the five senses. If the participant was unsure or said no, the researcher would present the participant with a five-sense poster printed from the educational website Twinkle (n.d). The procedure of the body object interaction task also followed the beginning introduction from the sensory experience. Participants were shown two different examples and asked if they understood what they were going to do. Once the participant was finished with the tasks, the researcher asked for feedback on how they felt the task went, if it was too difficult, just right, or too easy. Later, the researcher confirmed the next time they will meet to complete a different task.

2.8 Data Analysis

Data analysis for the different variables was conducted using the statistical program Jamovi (Version: 1.6., 2021). Analyses was done separately for each of the tasks. For the task on sensory experience, the independent variable is concreteness while the dependent variable is the ratings of the sensory experiences. For the task on environmental factors, the independent variable is the semantic representation, and the dependent variable is the environment. For the task on valence, the independent variable is valence and the dependent variable is ratings for the emotional scale.

The table for the independent bar plots and the valence rating for each word was created using Microsoft Excel (Microsoft 365). The boxplots were created using R statistical software (Version 4.20 for Windows, 2022).

Descriptive statistics consisted of bar plots that indicated individual responses from the sensory experience task and the body interaction task. The means and standard deviation for the variables were also presented. Additionally, to analyse how concrete and abstract words are grounded differently for individuals a paired t-test was conducted. The emotional rating was calculated by the distance to neutrality based on valence measures.

Inferential statistics were also conducted. The significance alpha level was set at $p = < .05$. To look for the relationship between sensorimotor and the activities done as a family, correlations were computed by computing the sum of the ratings for sensory experience, which is called Sum_ concrete and Sum_abstract. A correlation was also done for the variables in body object interaction. To look for a relationship between this semantic variable and the activities done as a family. We computed the sum of the rating for body object interaction, this led to a new variable labelled Sum_BOI concrete and Sum_BOI abstract. A scatterplot with linear

regression and Spearman correlation analysis was analysed to explore the extent how which sensorimotor properties are associated with the child's home environment and thereby assisting in their understanding of concrete and abstract words.

Results

In this chapter, the data from all the experimental tasks will be presented. The chapter is divided into four sections that include descriptive data on the participants, a description of the individual responses given by participants for the sensorimotor tasks, results from the sensorimotor and body object ratings, results from the emotional rating for the word referents, and finally, a section investigating the relationship between the experimental tasks and the variables from the parental survey, through correlation analyses.

3.1 Sample

Participants ranged from 6 to 8 years of age (M= 7.47, SD = 0.80). Table 2 shows an overrepresentation of participants in Grade 3 (47%). There were far fewer participants in Grade 1 (24%) and only slightly higher participation for Grade 2 (29%).

Table 2:

Frequencies of Grade and Gender

Levels	Counts	% of Total	Cumulative %
Gr1	4	24 %	24 %
Gr2	5	29 %	53 %
Gr3	8	47 %	100 %

Levels	Counts	% of Total	Cumulative %
Female	11	65 %	65 %
Male	6	35 %	100 %

3.*2* Results from sensory experience rating

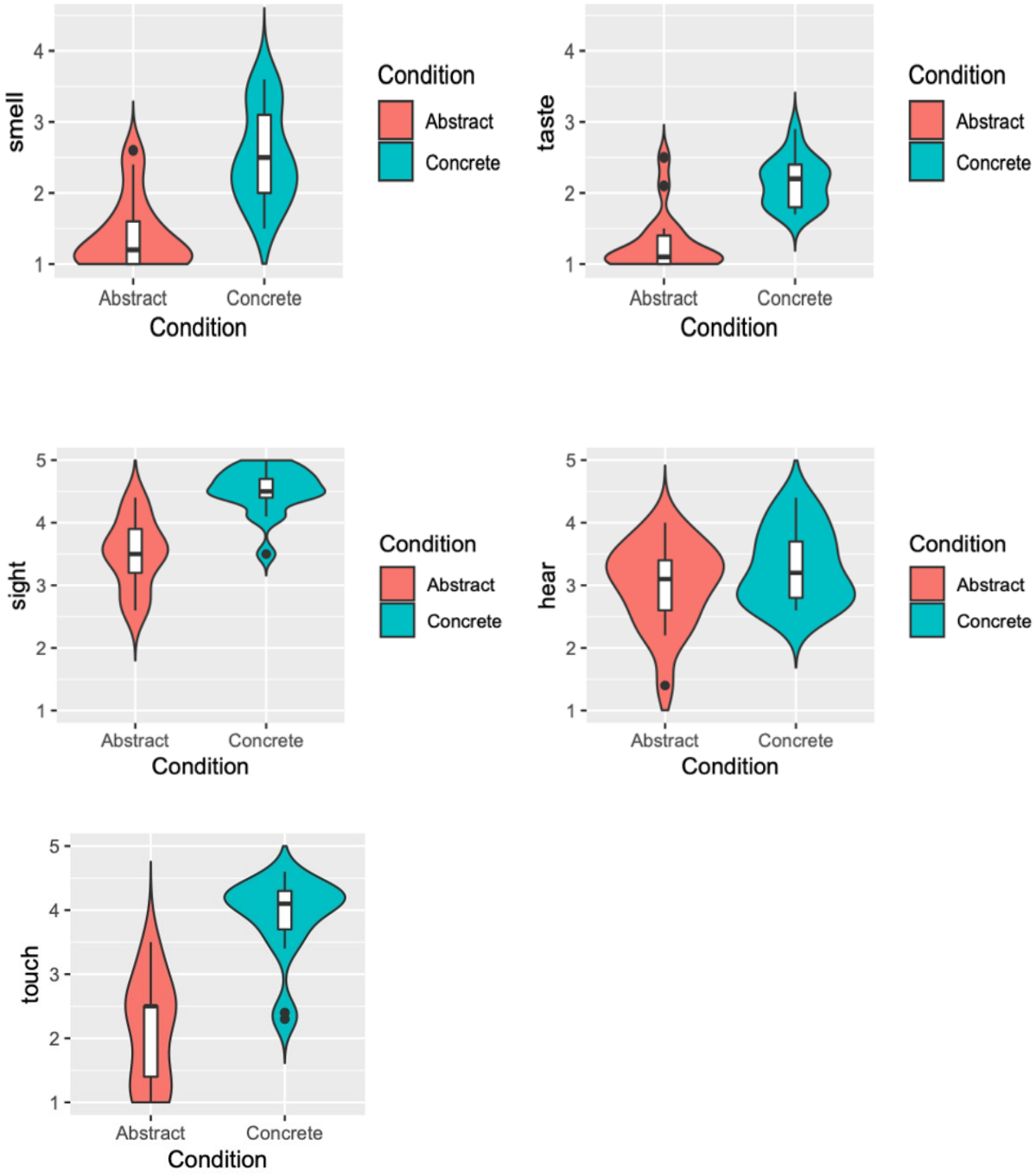
The comparison of concrete and abstract words on the sensory experience ratings is shown in Figure 1. Concrete and abstract words have different reliance, such as: abstract words relied on sight (M= 3.51, SD= .55) but to a lesser extent than concrete words (M = 4.51, SD =0.37). Abstract words did not rely on touch (M = 2.10, SD = 0.82) as compared to concrete words (M= 3.88, SD= 0.65). Histograms for the individual domains (smell, taste, sight, hear, and touch) have been added in Appendix H.

Abstract words did not rely on taste (M= 1.29, SD= 0.45), which is to a lesser extent than concrete (M= 2.15, SD = 0.33). Both concrete and abstract boxplots indicated outliers and the

scale for abstract words was lower than that of concrete words. The kurtosis value for variable abstract *taste* was 5.45 this indicated that the distribution was a heavier tail, which would indicate outliers in that variable.

Figure 1:

Boxplot of abstract and concrete words for sensory experience



A paired sample t-test was used to investigate the difference between the concrete and abstract means on the sensory experience rating in Table 5. Significance was indicated for

most variables (p = <.001). There was no statistically significant difference between concrete and abstract words on the dimension "hear", $t(16) = 1.80$, $p = .09$, Cohen's d = 0.44, we retain the null hypothesis. There is a relationship between concrete and abstract words on the dimension "hear".

Table 3:

Paired t-test for sensory experience ratings

Paired Samples T-Test

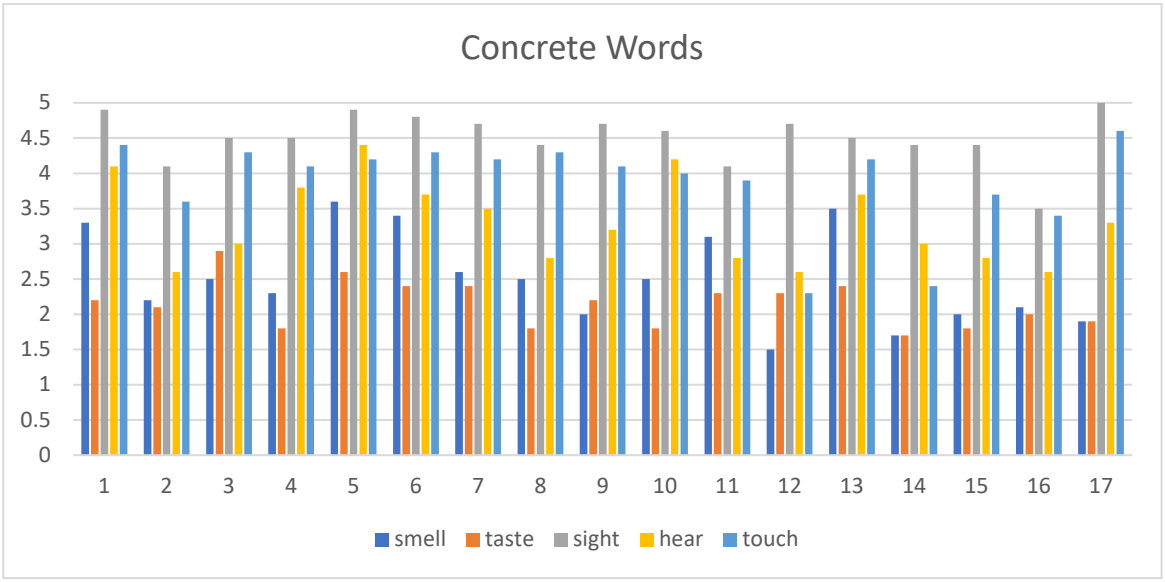
			statistic	df	p		Effect Size
concrete smell	abstract smell	Student's t	6.06	16.00	< .001	Cohen's d	1.47
concrete taste	abstract taste	Student's t	7.26	16.00	< .001	Cohen's d	1.76
concrete sight	abstract sight	Student's t	7.99	16.00	< .001	Cohen's d	1.94
concrete hear	abstract hear	Student's t	1.80	16.00	0.091	Cohen's d	0.44
concrete touch	abstract touch	Student's t	8.33	16.00	< .001	Cohen's d	2.02

Figure 2 indicated that individual responses to concrete words rated high on *sight*, which indicated that responses were similar and less in agreement with the domain of *taste* for concrete words. Abstract words indicated more variation in responses for individuals. Individual ratings for abstract words are less than the rating for concrete words on all the five domains (smell, taste, hear, touch, sight).

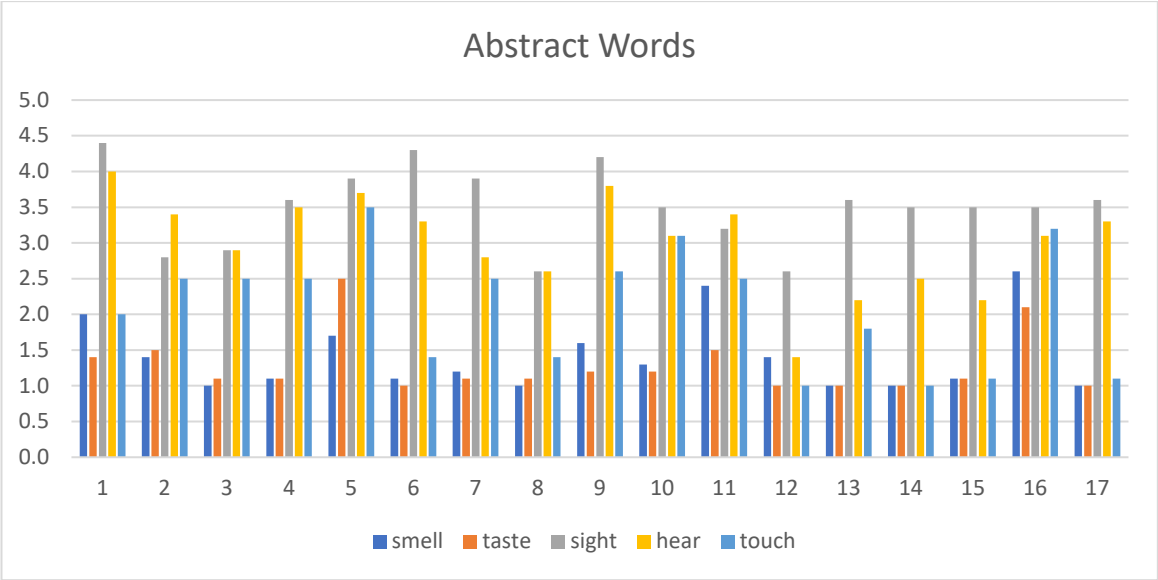
Figure 2:

Individual differences for concrete words and abstract words on the sensory experience

A.



B.



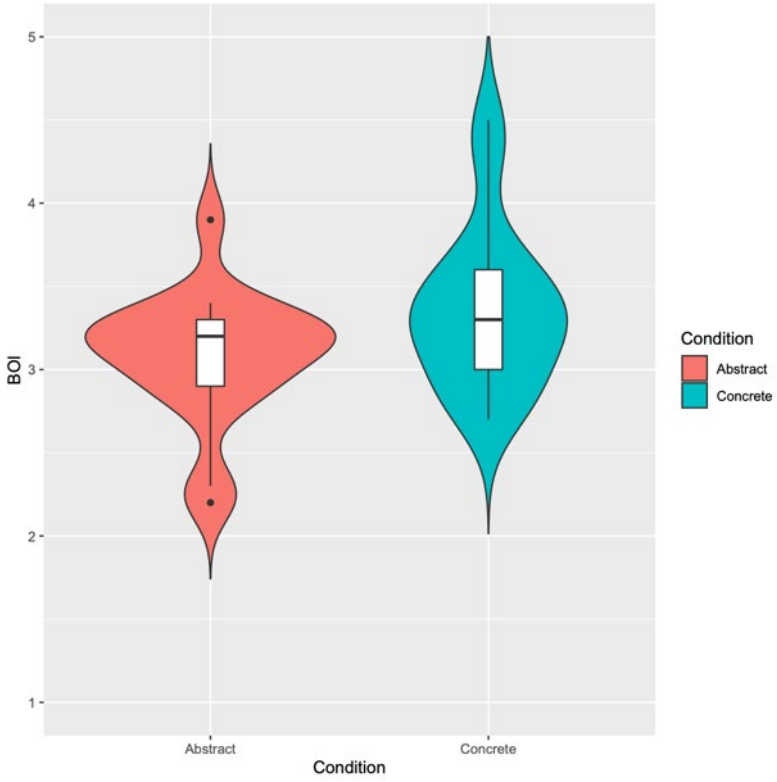
Note: Individual differences between concrete words (Panel A) and for abstract words (Panel B) on the sensory experience. The bar plots presents the participants individual responses. The numbers 1-17 correspond to the participant's response to the sensory rating, the scale is from 0-5 which represents the level of sensory rating.

3.3 Results for body object interaction rating

Concrete words were rated as having higher body-object interaction (*M*= 3.36, *SD*= 0.49) than abstract words (*M*= 3.08, *SD*= 0.40). Box plots in Figure 3, indicated outliers for Abstract BOI and the data is not as distributed and the boxplot indicated left skewness. Outliers indicated a large distance from the main values. Concrete BOI indicates a greater range for the overall sample than Abstract BOI. The median of Concrete BOI lies above the fourth quartile range of Abstract BOI.

Figure 3:

Boxplots for Concrete and Abstract BOI

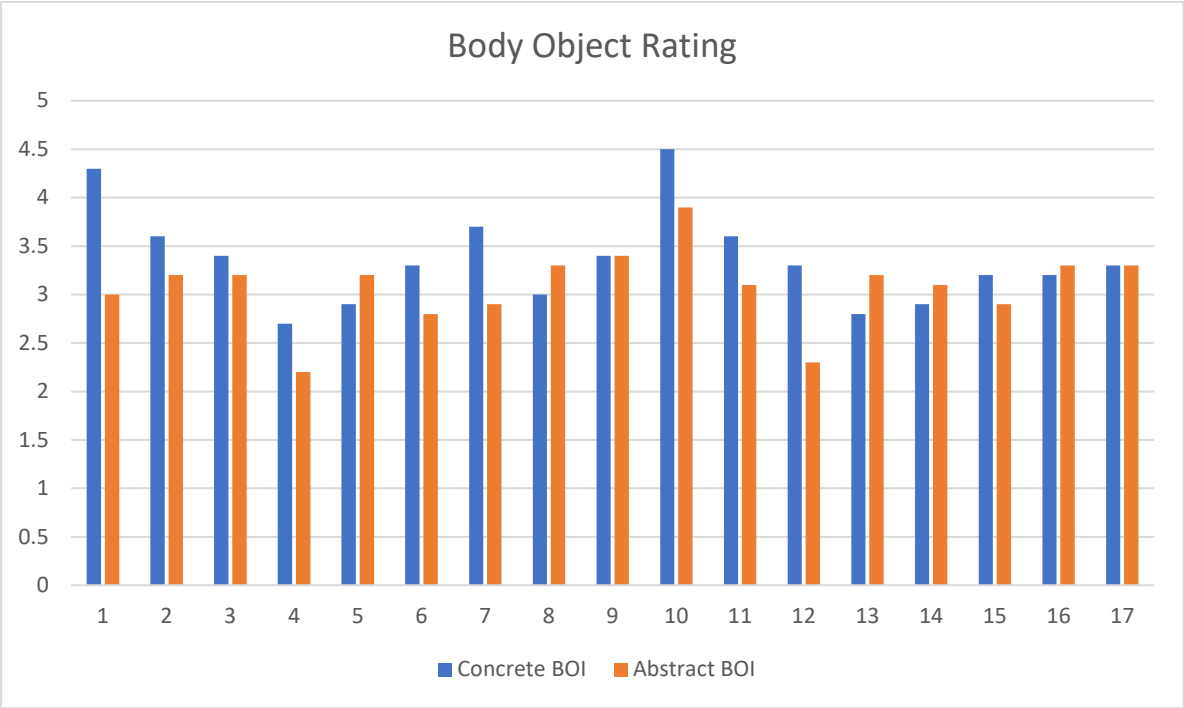


A paired sample t-test was conducted to compare the means scores of body object interaction rating for concrete and abstract words to test the hypothesis that concrete words are more grounded on body object interaction than abstract words. The variables passed the Shapiro Wilks test and therefore a paired student t-test was conducted. The paired t-test for showed the difference was significant, $t(16) = 2.40$, $p = .02$, the null hypothesis is rejected, there is a relationship between the two variables.

Figure 4 shows the individual responses for body object ratings. Individual responses are diverse with some individuals rating Concrete BOI higher than Abstract BOI. The lowest score for Abstract BOI was 2.3, while Concrete BOI was 2.7.

Figure 4:

Individual differences in rating for concrete vs abstract body object rating



Note: 1-17 corresponds to the participant, the rating for each word was from 1-5. This barplot indicates differences in responses between concrete and abstract words on the body image rating.

3.4 Results of concrete and abstract words on valence rating

Figure 5 demonstrates the distribution of data for concrete emotion words and abstract emotion words. The median for concrete words that refer to emotion was 1 and the median for abstract words that refers emotion was slightly lower than 1. The distribution for concrete emotion words was larger than for abstract emotion words with the abstract emotion words median being right below the lower quartile for concrete emotion.

Figure 5:

Boxplots for valence in both concrete and abstract words

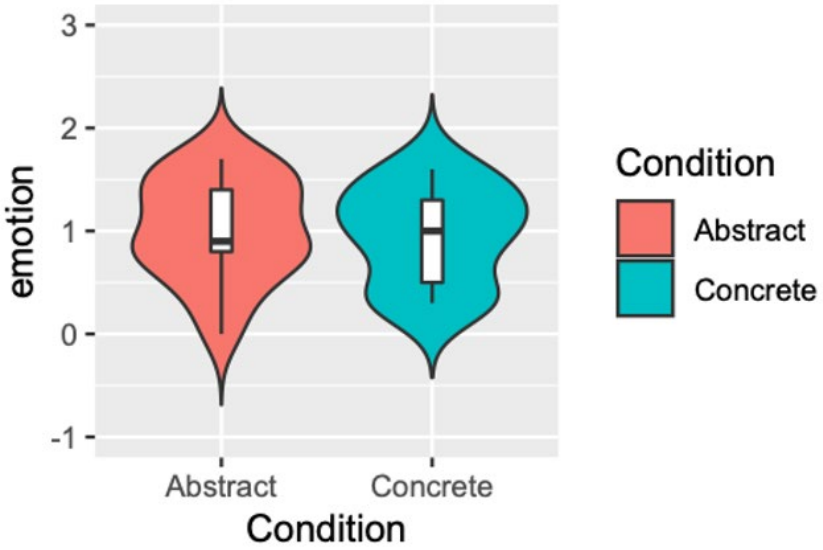
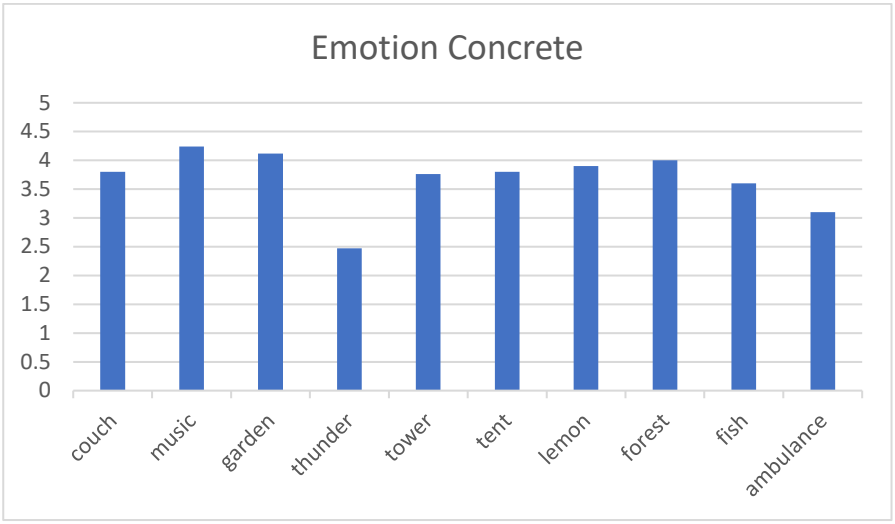


Figure 6 indicated the emotional rating of words as a function of concreteness, both concrete and abstract words were presented as an indication of positive or negative emotion. Words that are above 3 are indicated as positive and those below 3 are negative. The words *happiness* and *friendship* while considered abstract, were rated positively. The words *sadness, fear, danger,* and *ambulance* were rated negatively. We computed the distance to neutrality to investigate the emotional value.

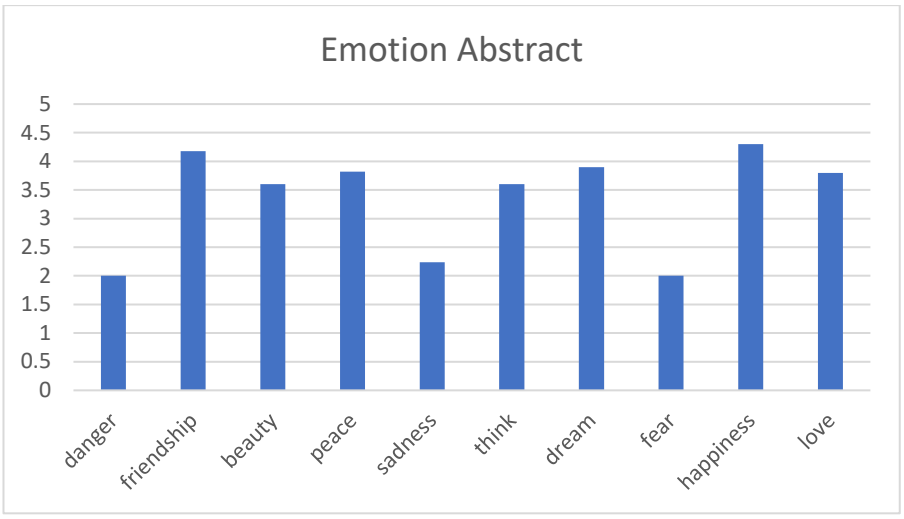
Figure 6:

Rating of the emotional valence words

A.



B.



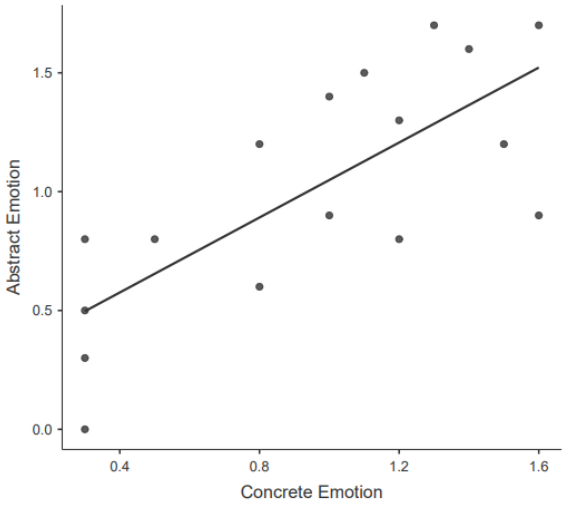
Note: Figure A corresponds to the individual concrete words used. The amount of rating for each concrete word was 1-5. Figure B corresponds to the individual abstract words used. The amount of rating for each concrete word was 1-5

To examine the extent to which concrete and abstract words are differently grounded across semantic representations from the sensorimotor tasks, a paired sample t-test was done to compare the means from the groups. The results of the t-test revealed that there was no statistical significant, $t(16) = -0.70$, $p = .49$, Cohen's $d = -0.17$.

Figure 7 showed a strong positive correlation between concrete emotion words and abstract emotion words ($r = 0.75$, $p = < .001$). The more concrete words were rated as positive, and the more abstract words were also rated as positive

Figure 7:

Scatter plot for the relationship between concrete and abstract words for emotion



3.5 Correlation

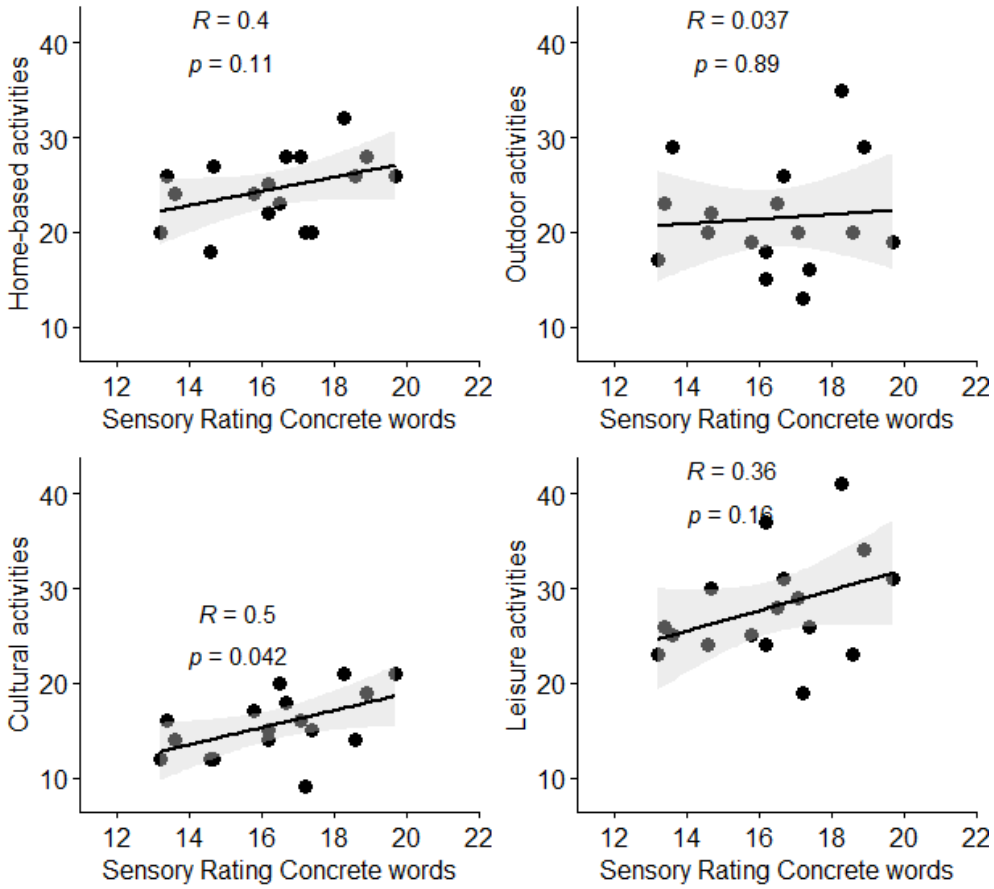
To explore the relationship between the sensorimotor properties of words and how the environment affects semantic representations scatterplots across all environment variables, such as home-based, outdoors, leisure, and cultural were computed. Spearman's rank correlation analysis was used to analyse correlation because it is less sensitive to outliers than Pearson's r.

In order to run correlation, the sum of each variable was calculated. We computed a new variable that reflected the strength of sensorimotor properties of words by doing the sum of the values for each rating, such as; rating for *smell*, ratings for *hearing*, ratings for *sight*, ratings for *touch*, and ratings for *taste*. The new variable for the sensory experience are, Sum_concrete and Sum_abstract. The same was done for body object interaction, we computed a new variable that reflected the strength of the sensorimotor properties of the words. The new variables were Sum_BOI concrete and Sum_BOI abstract

In Figure 8, we found significant moderate relationship between Sum_concrete and Sum_culture ($rs(15) = .50$, $p = .04$). The null hypothesis states the two-variable mean is zero and therefore the cultural activities a child does relate to the semantic representation of concrete words. A moderate trend for variables Sum_concrete and Sum_HomeBased ($rs(15) = .40$, $p = .10$) was observed but it was not significant.

Figure 8:

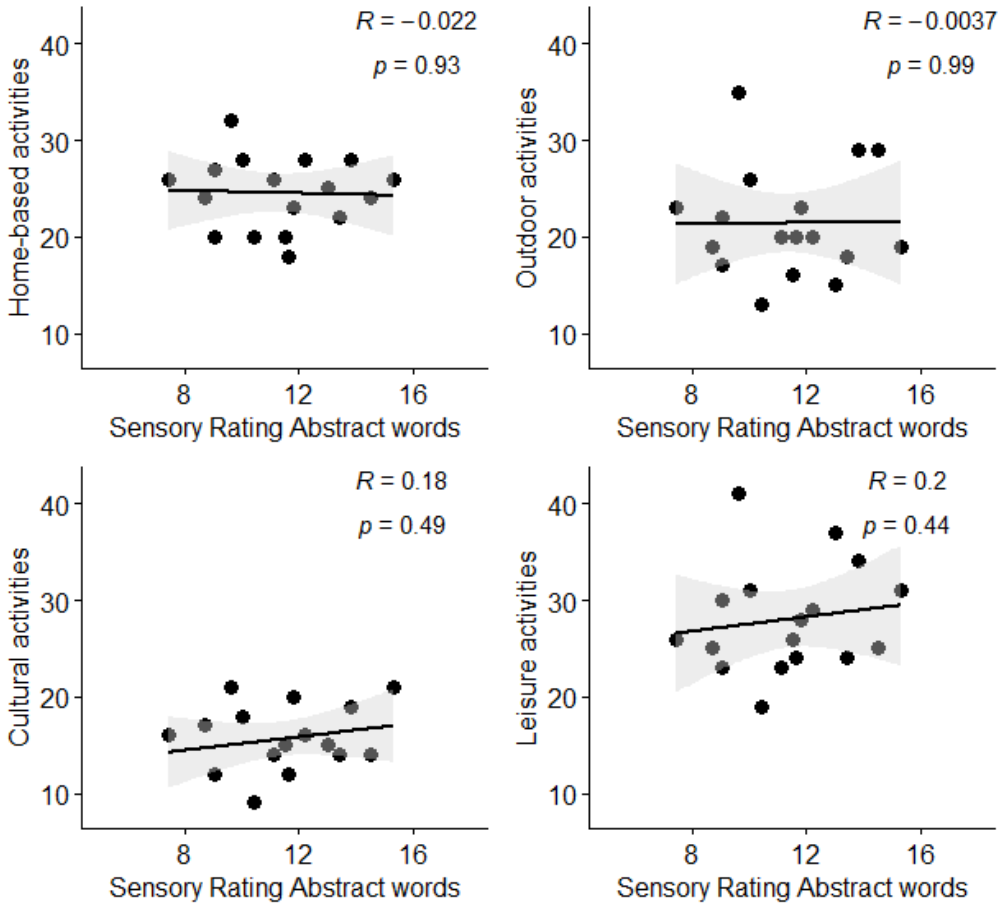
Scatterplot for Sum_concrete across the four environment variables



We did not find any significance between Sum_abstract (see Figure 9) and the remaining environment variables.

Figure 9:

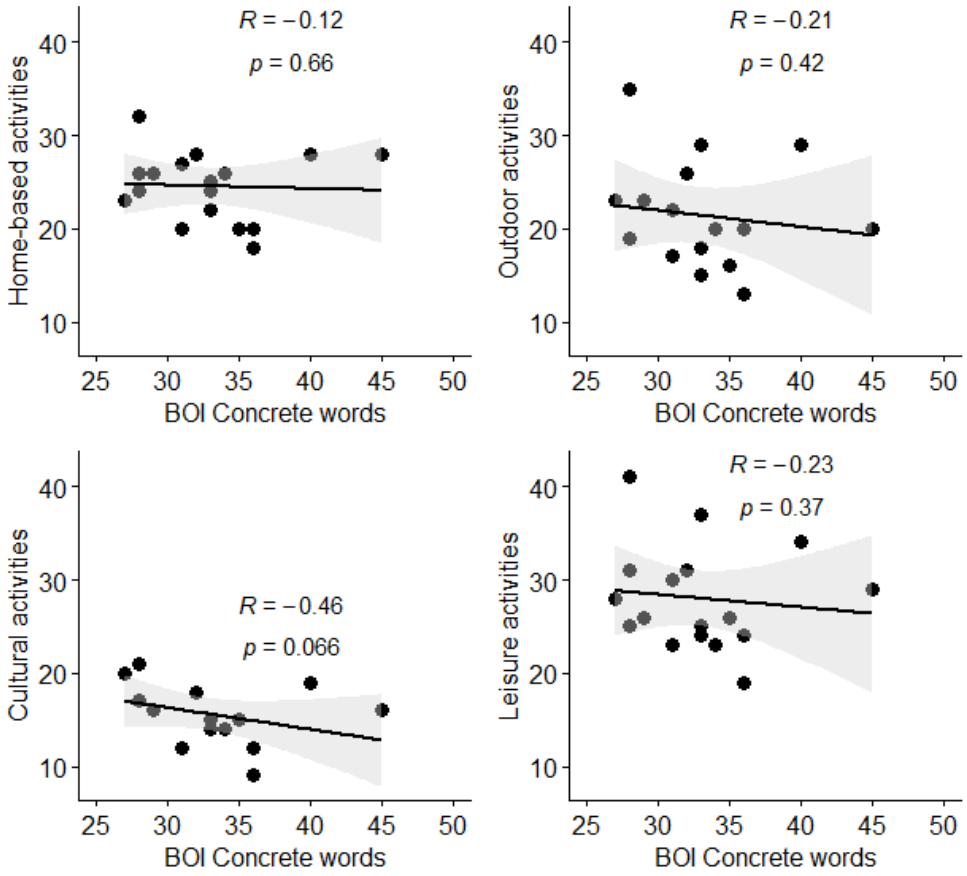
Scatterplots for Sum_abstract across all four environment variables.



The scatterplot for Sum_BOI Concrete words (see Figure 10), indicated a negative association and no significance between the variable Sum_BOI Concrete across the four variables of environment, the variables had no relationship.

Figure 10:

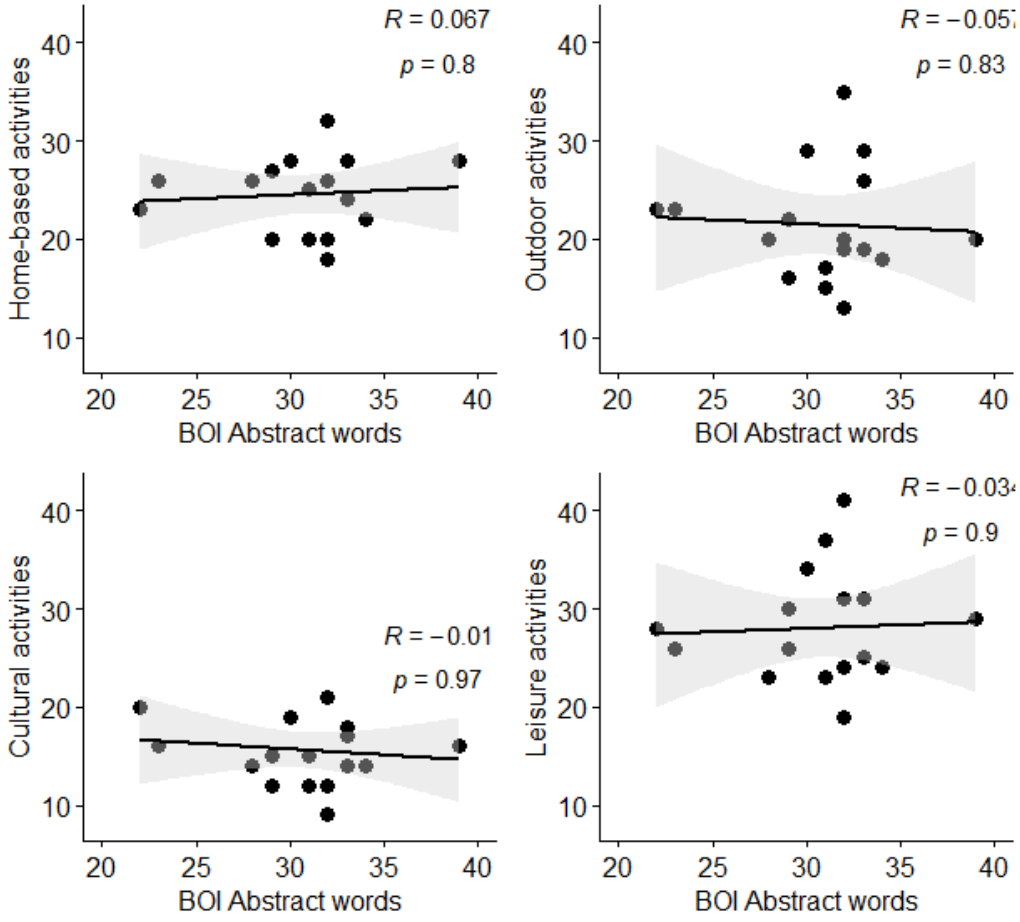
Scatterplots for Sum_BOI Concrete interaction across the four environment variables.



Scatterplot for Sum_BOI abstract (see Figure 11), indicated a negative non-linear relationship; the variables are scattered and fluctuate. Correlation analysis indicated no relationship between variables.

Figure 11:

Scatterplots for Sum_BOI abstract across the four environment variables.



Discussion

The main purpose of the study was to investigate how our individual sensorimotor experience affects our understanding of concrete and abstract words. This was done by exploring participants' responses to various sensorimotor tasks. The hypotheses were to explore how concrete and abstract words are grounded differently and to explore the degree to which our sensory experience interacts with the environment.

In this chapter, we will interpret the results and evaluate the findings. In addition, this chapter will highlight the limitations of the thesis which include its strengths and weaknesses of it. The final section of this section is closing remarks on the possibilities that emerged and how the thesis can be a starting point for more research on sensorimotor experiences and individual differences.

4.1 Interpretation of results

4.1.1 Results for sensory experience rating

The bar plot for sensory experienced showed a lot of variation in responses for each individual, which supports the subjectivity of the sensory experience tasks. But while there are variations between individuals, there are also variations between concrete and abstract words in the domains of sensory experiences (smell, sight, taste, touch, hear). In general, the participants rated concrete words in the domain of "sight" and "touch" higher than abstract words, this is in line with the prediction that concrete words would be more reliant on sensory experience. This makes sense since a child is reliant on their sense of touch and sight when encountering concrete words, you can touch and see a table, a couch, a tower, and a tent.

One interesting aspect shown in the results was that abstract sight was also higher than anticipated. This may be due to concrete objects that the participants associated with the abstract words, such as for the word *beauty*, some participants connected this to the idea of makeup. No notable different was present when comparing results for concrete and abstract words through the experience of *hearing*.

4.1.2 Results for Body object interaction

The results from the body object indicated that there was no difference for the ratings of the words and how one can physically interact with the word referent. Looking back at the individual bar plots for body object interaction, there is little diversity across the variables. There were some individuals that had equal scores for both concrete and abstract BOI. Some

of the participants rated some of the body object interaction words lower on concreteness. Pexman (2019) stated that while concrete words are almost always experienced visually, one can only experience some concrete words through physical manipulation but in these results, the participants rated physical interaction almost equally.

The research from Heard et al., (2018) investigate different semantic domains in relation to BOI for undergraduate students, likewise, Muraki & Pexman (2021), investigated how individual differences are present in motor imagery, and the study from Muraki et al., (2022), examined how body object interaction for child norms but had asked the parents of the child to rate words based on how easily their child could interact with the word. Thereby, the child themselves was not active participant in representing their understanding of how easily they can interact with words because the norm was already being set by their parents. The conundrum here is that if we want information on how children access and use the semantic variables acquainted with the sensorimotor, then more research should put the child at the forefront of it to gather data that is based on the child and not an extension of the child by asking undergraduate students, or parents.

4.1.3 Result for Valence

For this group of 17 participants, there was no difference between concrete and abstract words on the emotion measure. The findings showed a positive correlation between abstract and concrete words, meaning the participants who rated concrete words with positive emotions tend to also rate abstract words with positive emotions. This is a new finding as much of the literature makes a distinction between these two words but for this sample, there was no difference between abstract and concrete.

Examining the words individually, positive abstract words were *friendship, dream,* and *happiness.* While these words are considered abstract because they cannot be experienced through the senses, it makes sense, in a way, that children of this age rank friendship higher than beauty or love because friendships are important at a young age, so their experience to this word is positive, regardless of it being abstract. The word *happiness* also achieved a high rating for positive emotion, again, this is likely because happiness is an emotion that is learned earlier in life and there are many experiences and interactions that a child might rate as happy, such as; playground time in school, friends, something that is considered fun. This is in accordance with the literature that explains that emotions are attached to abstract words since abstract words lack sensorimotor properties.

4.1.4 Correlation

It can be argued that the correlation between Sum_cultural and Sum_concrete is due to the nature of the activities listed under the Sum_cultural variable. When attending music and food festivals for example, sensorimotor is emersed in an interactive, dynamic environment. In which several senses are simultaneously impacted, such as listening to music, tasting and smelling food, dancing to favourite songs. Referring to the multimodal approach discussed in the first chapter of this paper, the meaning of words is acquired through different domains: social, sensory, and motor.

Contrary to this paper's predictions, there was no relation between the either of the two Sum_BOI variables or the Sum_abstract variables to the four environment variables was found in the research results. The hypothesis that the results would present a positive correlation among all the variables was incorrect. The small sample size and the activities that were used for each category for the environment, Outdoor Leisure, Cultural, and Home-Based, could explain this result.

4.2. Limitations of the study

The sample size is small and cannot represent a generalization of the population. At the same time, while it was a small sample.

Reflecting on the methods used, the questionnaire had limitations and room for further development and improvement. More questions that kept in line with how often the family unit engaged in certain activities, or if they belong to any extracurricular clubs, would have been useful. While the questionnaire asked about the home language and reading language, these two variables at the end did not seem important in exploring abstract and concrete words, and instead, more emphasis should be placed on the interactions through joint activities. Further, the questionnaire had a rating, *other* but participants were not able to type what that other activity was and therefore, it was a missed opportunity to gather further data on what the family did together. Moving forward, having the child participant also complete a simple questionnaire on the activities they enjoy doing could also strengthen this research.

Keeping in line with Muraki et al., (2019) and how language is situated and Barsalou's (2020) Situated Action Cycle which includes several different dimensions for individual differences, the questionnaire assigned to the parents was a starting point towards developing a more rounded and defined representation of the child's home environment.

The study replicated some elements previously done in exploring abstract and concrete words, but modifications of tasks and execution of tasks were independent of that of previous studies. Tasks were tailored to be child friendly given the age of the participants. Another difference from previous research is that the researchers were able to visit the schools and have some interaction with the participants. This gave the researcher the opportunity to sit with the participants and listen to any interesting comments made throughout the task.

Furthermore, the selection of the twenty words used for the study, these words were not easily transferable to the different activities listed for the environment. Only two or three words had a link to certain activities, for example, the words *forest, danger,* and *tent* could be associated with the activity of hiking which was under the main topic of Outdoor activities in the parental survey. Therefore, it can be argued that there was a disconnection between the words used and the overall main categories in the Parent Survey.

4.3 Transforming classroom learning

What is the preferred method to map the multidimensional semantic richness that underlies individual differences? This is one of the questions in the study that needs to be addressed to obtain a deeper understanding of individual differences. One aspect for further exploration is the relationship between semantics and reading levels. We can assess this causation through the sensorimotor process in how we teach and engage students when understanding the meaning of words.

In terms of the implications on teaching, as stated in this paper's introduction, embodied and sensorimotor in classroom learning and teaching is an established method, it remains to be seen, however, how we can further implementation this concept in our education system. There is no lack of evidence proving sensorimotor rich experiences and their positive correlation to learning outcomes. As Fugario et al., (2019) state students who engaged in rich sensory experiences were able to retain the learned knowledge longer than students who did not receive a sensorimotor rich learning environment. But it is also important to remember that not all motion is automatically "embodied" or related to the context of the learning being involved. Sensorimotor stimulation and cognition are best when it is in relation to the context of *what* is being learned. In other words, if the action is out of the context of the learning (being the text, the concept) then Vocabulary words that can be manipulated, can be by acting it out, singing, or looking for other semantic features that relate to the words may be more impactful for the learning than simply copying the definition or writing a sentence using the

word. How can we expect a student to write a cohesive sentence using a word that they do not understand yet?

For an educator, it is important to understand the knowledge of words from the student's point of view by developing experiences and learning activities that help the students acquire the shared meaning of a word. In this way, the construction of shared meaning is obtained by both the teacher and the student. We, as adults, may not share the same meaning of words in line with the student, as we have been exposed to different experiences and interactions with different words. Not only do children have different experiences based on their interaction with their environment, but children use multiple different modes to express meaning (Thomas Jha et al., 2021). Therefore, one activity that can be used to develop shared meaning is through acting out or miming the words. The teacher can also become more in tune with the nonverbal gestures a student uses when explaining different words. Using the sensorimotor as a proxy, can help the teacher have a clear overview of how the students perceive different words, for example, when being introduced to the word *caring*, the teacher could ask the child how they experience this word through the senses and have the child give it an emotional rating, much like the tasks done for this thesis. In this manner, the teacher can use the information to structure further learning for the students both as individuals and as a group.

What would the best method be to compute the multidimensional semantic richness that addresses individual differences? This is one of the questions moving forward in the study that needs to be addressed to gain a better understanding of individual differences.

4.4 Future Research

As research on the field of embodiment progresses, consideration of the extent to which sensorimotor processes could be used as an intervention for students with special needs could be explored. As Kosmos et al., (2016), highlights, no research examining the impact of sensorimotor learning on children with autism currently exists. Furthermore, as more research is conducted on the role of our sensorimotor and the cognitive domain continues to grow, it should be noted that the majority of these studies are conducted withing typical children and adults as their subjects, there is a gap and need to extend this study's scope to include children with special needs.

There has been some research on how embodied learning has demonstrated positive results when it is used in special needs, specifically by implementing the use of Kinect based

educational games. These types of games provided a whole-body experience, where you need to provide motion that is in context with the task being asked for, this movement might be pointing, grasping, walking, or moving. The study from Komos et al., (2018) looked at how motion-based learning can be used on students with special needs in mainstream schools. The results of the study demonstrated that students showed more engagement in the learning tasks, showed more motivation, and overall enthusiasm for the tasks. This is an important point for embodied learning and its use for special needs education. The use of motion-based learning is correlated with the theoretical background on multimodal learning and providing the students with this opportunity is twofold. In one aspect, the student is engaging in meaningful sensorimotor interactions and the other aspect is that the student can have the opportunity to engage with other members of the class, thus forming social interactions and shared experiences.

Another future approach is to conduct research on a more qualitative approach, thereby bringing in the possibility of a different perspective on embodied learning and sensorimotor experiences. An example of a qualitative approach might be to transcribe what the participants are saying during the sensorimotor tasks. This might provide further insight into why the participant chose a certain rating, was it based on their experience with the word (environment), or was it more likely to be based on their own feelings towards the word? Another qualitative approach might be more focused on the teachers' understanding of embodied cognition. Surveys, interviews, or video recordings can take place to provide more understanding of the theory. Most of the research currently done regarding sensorimotor experience is displaced in a sense, because the research is done in a lab rather than in the actual domain in which children are learning. Other than the research from Gómez et al., (2021), no other significant research has been carried out in schools.

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Appendices

Appendix A: Request to conduct research at a school letter

Universitetet i Oslo
Boks 1072 Blindern
0316 Oslo

"How does our sensorimotor process affect our understanding of concrete and abstract words"

Letter of invitation to Schools

My name is Melissa Mimbela, and I am a master's student at the University of Oslo. I am conducting research under the supervision of Dr Raphael Fargier. This research project will begin in mid-February. The research project has been notified to the Norwegian Centre for Research Data and complies with data protection legislation. I would like to invite you to consider taking part in this research.
I am also an experienced teacher and have worked at IB schools in Norway and Florida. I have taught in Year 1, Year 2, and Year 4 (paternity cover), as well as an SEN assistant. My interest in this research project flourished from the inquiry of language, and the development and understanding of word usage on an individual level.

Aims of the Research
The research aims to:

1. Explore the different factors that contribute to semantic differences across children
2. Explore how language is situated through experiences and interactions.

Significance of the Research Project
This research will provide further data on the relationship between our sensorimotor experience and language development across learning. Additionally, it will provide insight into better methods of instruction of semantics and vocabulary acquisition for children that may require special education.

Research Plan and Methods
For Parents:
Parents will kindly be asked to complete an online questionnaire that will be administered through Nettskjema. This questionnaire will focus on how language is used at home.

For Students:
The students from Years 1 -3 will be invited to participate in this research. Students will be asked to complete a computerized survey that will collect data on the sensorimotor acquisition

of various words. The second task will involve collecting an audio recording of the responses to different words being presented by the experimenter, this task will take approximately 7- 8 minutes. As with the first task, participants will be given a break. The reason for these types of tasks is to gather data on semantic categories and associations.

The approximate time for the student tasks will be held over two-three days, so the student is not overwhelmed during the tasks. Currently, the tasks are under development to ensure that it is child friendly and comprehensible. Data collection will be administered by the researcher (myself) and the approximate time for the tasks depends on the student. The student must have a break.
Permission will be sought from the students and their parents before they participate in the research. All information collected will be treated in the appropriate method, so the school and its learning community are not identifiable.

The role of the school is voluntary, and the School Principal may decide to withdraw participation at any time without penalty.

School Involvement
Once I have received your consent to approach parents and students to participate in the study, I will:

- Arrange a time with your school for data collection to take place.
- Obtain informed consent from all participants
- Keep the school informed of any changes

Invitation to Participate
If you would like your school to participate in this research, please complete the Nettskjema form that you will have access to.

Thank you for taking the time to read this information.

Sincerely,

Melissa Mimbela
melism@student.uv.uio.no

Masters' student
University of Oslo

Raphael Stephane Fargier
raphael.fargier@isp.uio.no

Supervisor
University of Oslo

Appendix B: *Parental Consent Form as presented in Nettskjema.*

Are you interested in taking part in the research project

"Development of semantic knowledge"?

We invite you to participate in a research project on understanding individual differences in semantic knowledge. In this letter, you will receive information about the purpose of the research and what your participation would entail for this research.

Purpose of the project

This Master's thesis will explore and define the correlation between the context in which language learning occurs and how it builds on semantic knowledge. The goal of this research is to determine what are the individual differences on semantic knowledge and how it relates to experiences. We believe that further data on language development and acquisition may provide insight into better methods of instruction and intervention for children.

Who is responsible for the research project?

The University of Oslo is the institution responsible for the project.

Why are you being asked to participate?

This research is focused on lower primary children. Participants that have been contacted are mainly from International Schools located in Norway. The expected sample size for this research is 1-99 participants.

What does participation involve for you?

Parental participation in this research involves one online survey through *Nettskjema* which should not take more than 6-7 minutes to complete. The purpose of the survey is to gather information on socio-demographics and language experiences, such as occupation, degree of education, language used at home, and social activities enjoyed as a family. Your answers will be recorded electronically.

Participation from your child will involve three tasks. Two tasks are completed on a computer through *Nettskjema* and would take approximately 15-25 minutes. Participants will be given 2–3-minute breaks. These two tasks will collect data on sensorimotor acquisition of various words.

The third task will involve collecting an audio recording of the responses to different words being presented by the experimenter, this task will take approximately 7- 8 minutes. As with the first task, participants will be given a break. The reason for these types of tasks is to gather data on semantic categories and associations.

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The third task will involve collecting an audio recording of the responses to different words being presented by the experimenter, this task will take approximately 7- 8 minutes. As with the first task, participants will be given a break. The reason for these types of tasks is to gather data on semantic categories and associations.

Participation is voluntary
Participation in the project is voluntary. If you chose to participate, you can withdraw your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

Your personal privacy – how we will store and use your personal data

We will only use your personal data for the purpose(s) specified in this information letter. We will process your personal data confidentially and in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

The Master student and the supervisor for the programme will have access to the data.

- Before the results of the research are submitted for publication, participants' personal data will

be anonymized and their online ID will be replaced with a unique auto-generated ID making further identification impossible.

By default, processing data will be conducted on encrypted laptops maintained by UiO and/or on encrypted memory stick/external hard drive, and/or using institutional services provided by UiO (e-
mail, storage). If this is not possible, processing data on password-protected personal devices will be
allowed, provided that the access is limited and controlled per user.

Our guidelines are that:

 only data that we are currently actively working on can be stored on private devices, for a limited period of time.

 synchronization of several folders is not allowed

 other users of the device do not have access to the data

 the computer is used in a safe way and is properly protected (e.g. automatic security

patching enabled, automatic locking screensaver, passwords changed regularly,

encrypted hard drive).

Only institutional services provided by the University of Oslo will be used to store the data.

What will happen to your personal data at the end of the research project?

The project is scheduled to end on June 1, 2024. At the end of the research project, all anonymising data will be retained for further studies.

Your rights

So long as you can be identified in the collected data, you have the right to:

-access the personal data that is being processed about you

-request that your personal data is deleted

-request that incorrect personal data about you is corrected/rectified

-receive a copy of your personal data (data portability), and

-send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

What gives us the right to process your personal data?

We will process your personal data based on your consent.

Based on an agreement with Oslo University, NSD – The Norwegian Centre for Research Data AS has assessed that the processing of personal data in this project is in accordance with data protection legislation.

Where can I find out more?

If you have questions about the project or want to exercise your rights, contact:

- the Masters student, Melissa Mimbela (melism@student.uv.uio.no, melissa.mimbela@gmail.com
- University of Oslo, Supervisor Raphaël Fargier (raphael.fargier@isp.uio.no).
- Our Data Protection Officer: Roger Markgraf- Bye (personvernombud@uio.no)
- NSD – The Norwegian Centre for Research Data AS, by email: (personverntjenester@nsd.no) or by telephone: +47 55 58 21 17.

Yours sincerely,

Project Supervisor	Student
Raphaël Fargier	*Melissa Mimbela*

Consent Form *

I have received and understood information about the project *Development of semantic knowledge* and have been given the opportunity to ask questions. I give consent:

- ○ Yes, I give consent for my child to participate in all tasks and for myself to participate in the survey for this research
- ○ No, I do not wish for my child or myself to participate

Appendix C: Initial word referents

WORD	CONCRETNESS	SUBTLEX	AoA
People	4.82	56252	3.52
Couch	4.71	1197	3.74
Music	4.31	7734	3.81
fish	5	4258	4.05
Danger	2.68	2227	4.61
Lemon	5	613	4.74
Think	2.41	137261	4.76
sadness	1.82	244	4.78
Dream	2.6	6798	4.88
hope	**1.25**	16352	4.89
thunder	**4.34**	679	4.89
Beauty	2.93	2460	5.05
Mug	4.8	349	5.15
Love	2.07	56864	5.17
garden	4.73	1354	5.33
Friendship	2.39	1164	5.62
find	2.63	42379	5.78
Goodness	1.38	1655	6.05
Cabinet	4.89	425	6.06
Swan	4.96	348	6.32
peace	1.62	3550	6.32
tower	4.76	1165	6.33
Luck	1.33	7840	6.53
trust	2.04	9087	6.55
Deliver	1	1446	6.63
Buffalo	4.83	607	6.7
freedom	2.34	1688	7.05
Tulip	5	40	7.15
Grace	1.78	2157	7.29
creature	4.07	1092	7.32
sculpture	**4.47**	159	7.47
greed	1.53	245	7.63
knowledge	1.73	1310	7.68
envy	1.69	487	8.37
Courage	1.52	642	8.42
certificate	4.59	458	8.42
sorrow	**2.36**	350	8.42
surgeon	4.54	838	8.58
Mineral	4.41	132	8.67
dance	4.32	7550	8.72
Crisis	2.33	849	9
Misery	2.04	523	9.22
Mannequin	4.53	62	9.24
Justice	1.45	1910	9.47

Appendix D – Parent Survey as it appears on Nettskjema

Mandatory fields are marked with a star *

Your name (first name and surname)? *

What is your child's name? *

I am the:

Select ...

What is your occupation

What is the highest educational level you have?

Select ...

What language(s) do you use at home to communicate to your child? (use commas to separate languages if there are several) *

When reading with your child, what is the language(s) that is mostly used. *

The following section is asking for input on what activities are done as a family. The reason for these questions is to gather some information about the different contexts in which language is situated.

How often do you and your child engage in recreational activities together? (physical activities)

	never	rarely	occasionally	moderate	A great deal
hiking/walking in the forest	○	○	○	○	○
swimming	○	○	○	○	○
cycling	○	○	○	○	○
cross country or alpine skiing	○	○	○	○	○
gardening	○	○	○	○	○
sailing	○	○	○	○	○
camping	○	○	○	○	○
other	○	○	○	○	○

How often do you and your child engage in home-based activities together

	never	rarely	occassion-ally	moderate	a great deal
arts and crafts	☐	☐	☐	☐	☐
cooking/baking together	☐	☐	☐	☐	☐
watching a movie	☐	☐	☐	☐	☐
playing video games	☐	☐	☐	☐	☐
playing board games	☐	☐	☐	☐	☐
creating a science experiment together	☐	☐	☐	☐	☐
other	☐	☐	☐	☐	☐

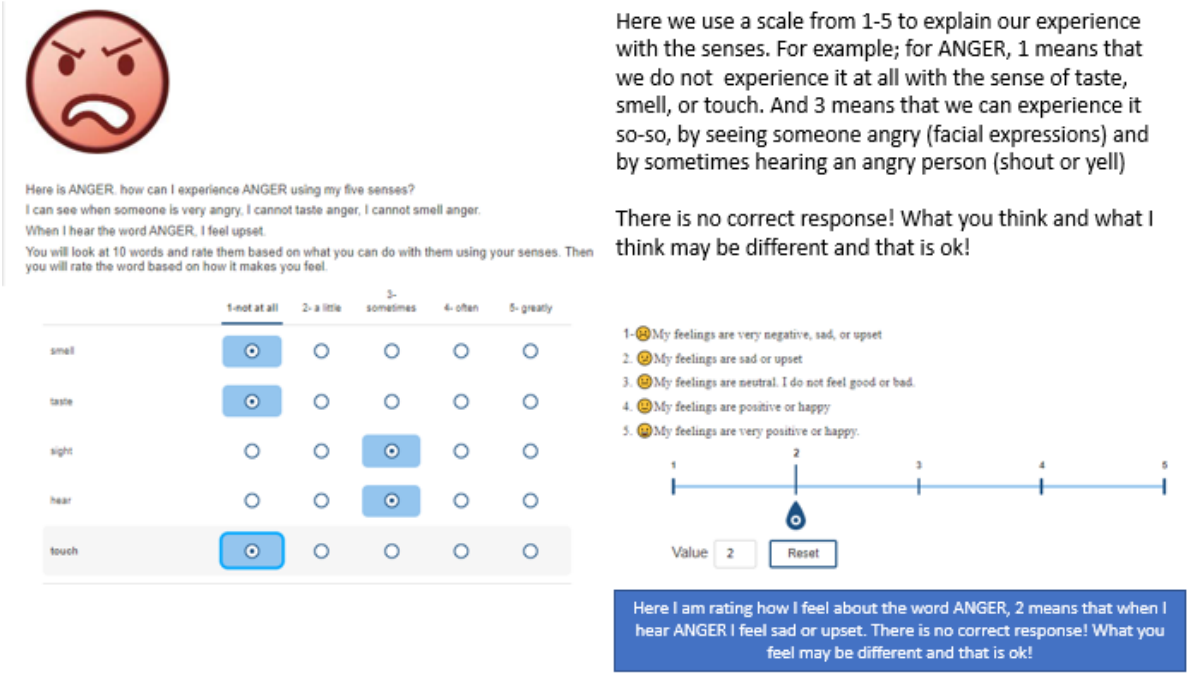
How often do you and your child engage in cultural activities together

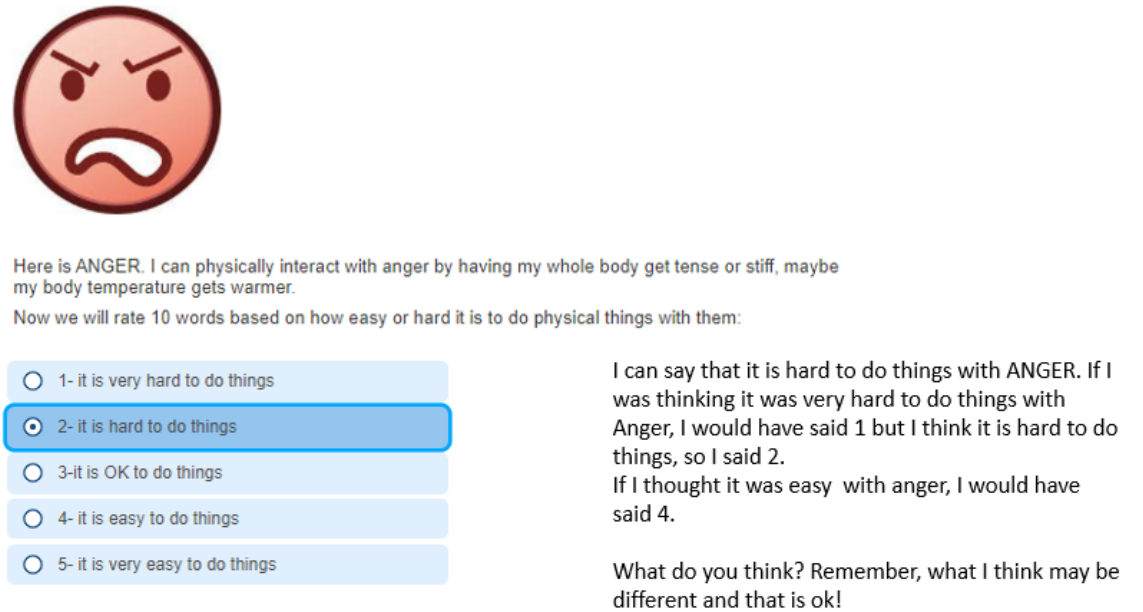
	never	rarely	occassion-ally	moderate	a great deal
visiting a museum	☐	☐	☐	☐	☐
food festival	☐	☐	☐	☐	☐
music festival	☐	☐	☐	☐	☐
visiting a historical site	☐	☐	☐	☐	☐
attending the ballet	☐	☐	☐	☐	☐
attending the opera	☐	☐	☐	☐	☐
other	☐	☐	☐	☐	☐

How often do you and your child engage in leisure activities together

	never	rarely	occassion-ally	moderate	a great deal
visiting the library	☐	☐	☐	☐	☐
movie theater	☐	☐	☐	☐	☐
playing an instrument	☐	☐	☐	☐	☐
listening to music	☐	☐	☐	☐	☐
mediatating	☐	☐	☐	☐	☐
painting together	☐	☐	☐	☐	☐
enjoying a stroll in the city	☐	☐	☐	☐	☐
grilling outdoors	☐	☐	☐	☐	☐
other	☐	☐	☐	☐	☐

Appendix E- Sample of examples used for participants before beginning tasks





Appendix F: *Sample of the Sensory experience and valence rating task*

How much can you experience the word COUCH, by your senses

	1-not at all	2- a little	3- sometimes	4- often	5- greatly
smell	○	○	○	○	○
taste	○	○	○	○	○
sight	○	○	○	○	○
hear	○	○	○	○	○
touch	○	○	○	○	○

When you hear the word COUCH, how does it make you feel?

1-☹My feelings are very negative, sad, or upset

2. 😕My feelings are sad or upset

3. 😐My feelings are neutral. I do not feel good or bad.

4. 🙂My feelings are positive or happy

5. 😀My feelings are very positive or happy.

Appendix G: *Example of the Body Object Interaction Task*

How can you physically interact, that is, can you easily do things with COUCH or is it hard

- ○ 1- it is very hard to do things
- ○ 2- it is hard to do things
- ○ 3- it is OK to do things
- ○ 4- it is easy to do things
- ○ 5- it is very easy to do things

How can you physically interact, that is, can you easily do things with DANGER or is it hard

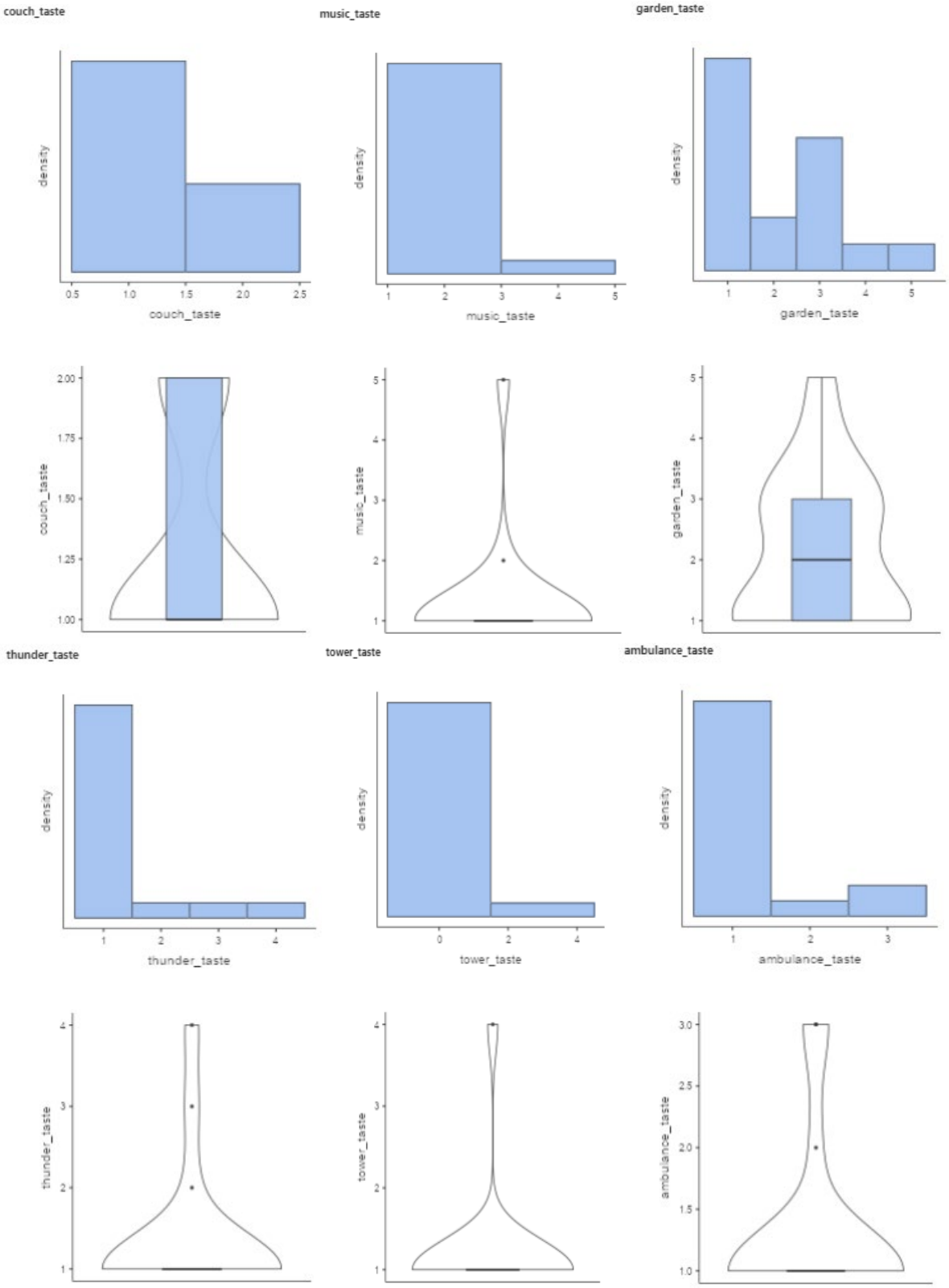
- ○ 1- it is very hard to do things
- ○ 2- it is hard to do things
- ○ 3- it is OK to do things
- ○ 4- it is easy to do things
- ○ 5- it is very easy to do things

How can you physically interact, that is, can you easily do things with MUSIC or is it hard

- ○ 1- it is very hard to do things
- ○ 2- it is hard to do things
- ○ 3- it is OK to do things
- ○ 4- it is easy to do things
- ○ 5- it is very easy to do things

Appendix H: *Independent variable results for all sensory experience words*

Dispersion of means for concrete and abstract words for taste



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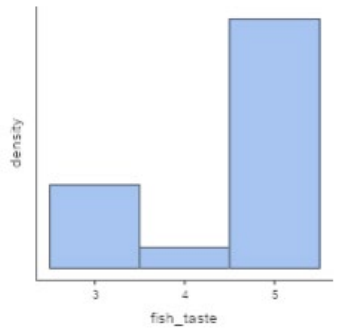
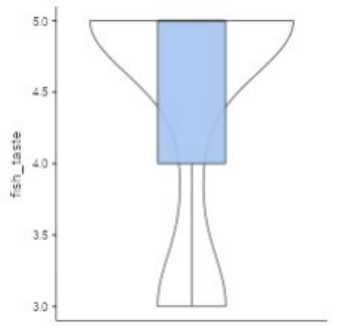
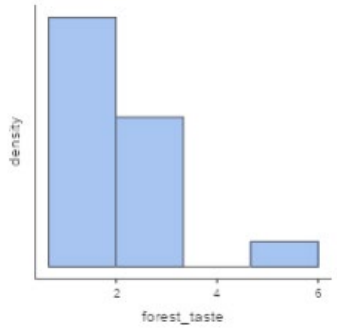
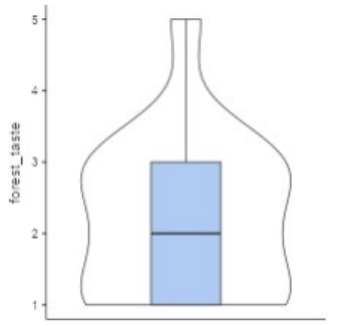


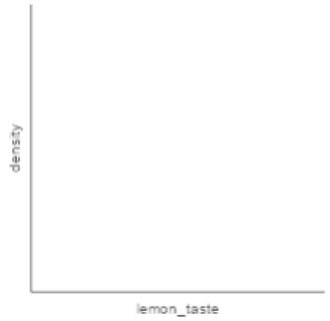


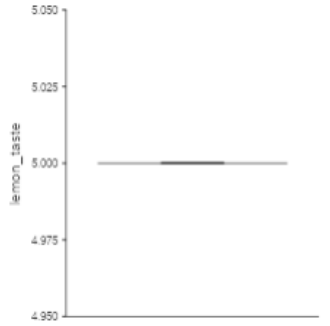
forest_taste



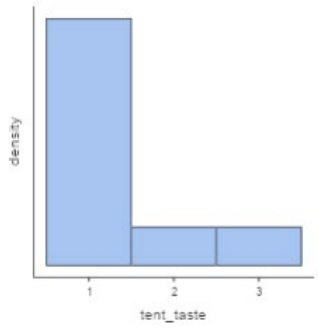


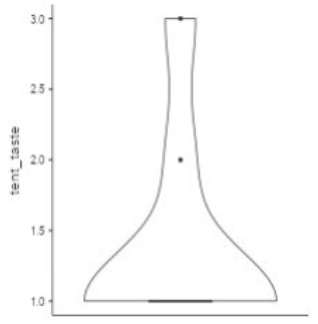
lemon_taste



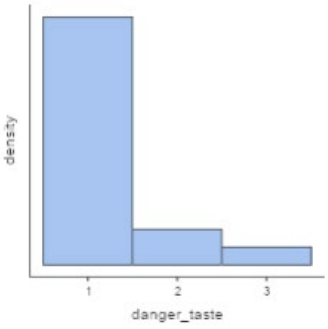


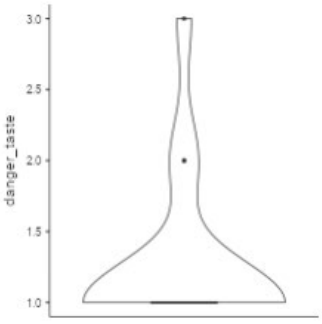
tent_taste



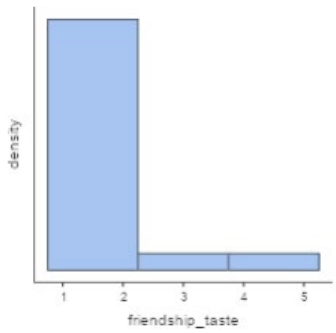


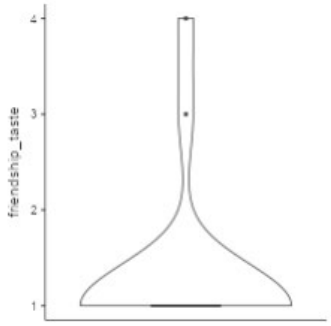
danger_taste

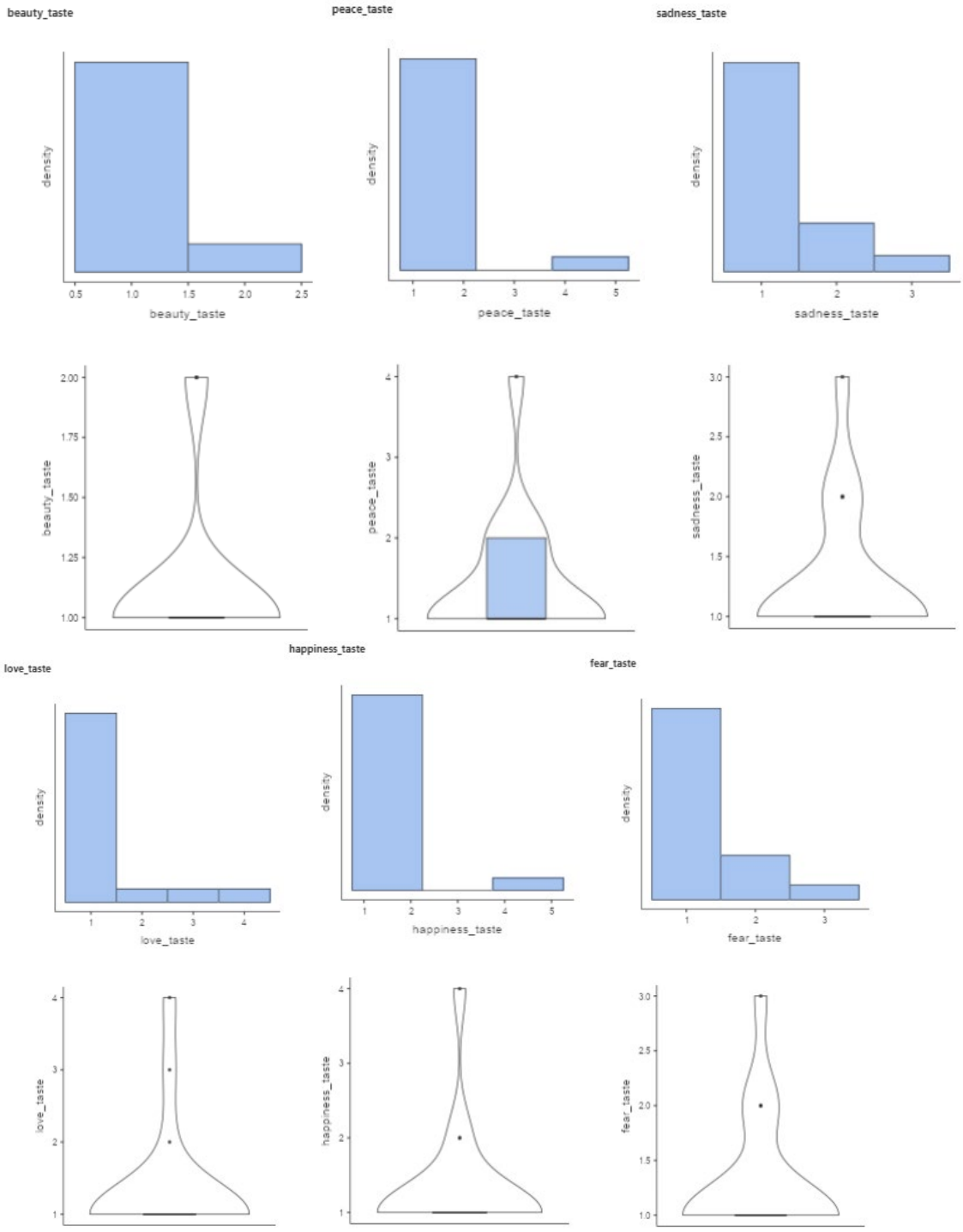




friendship_taste



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density
sadness_taste
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sadness_taste
happiness_taste
love_taste
density
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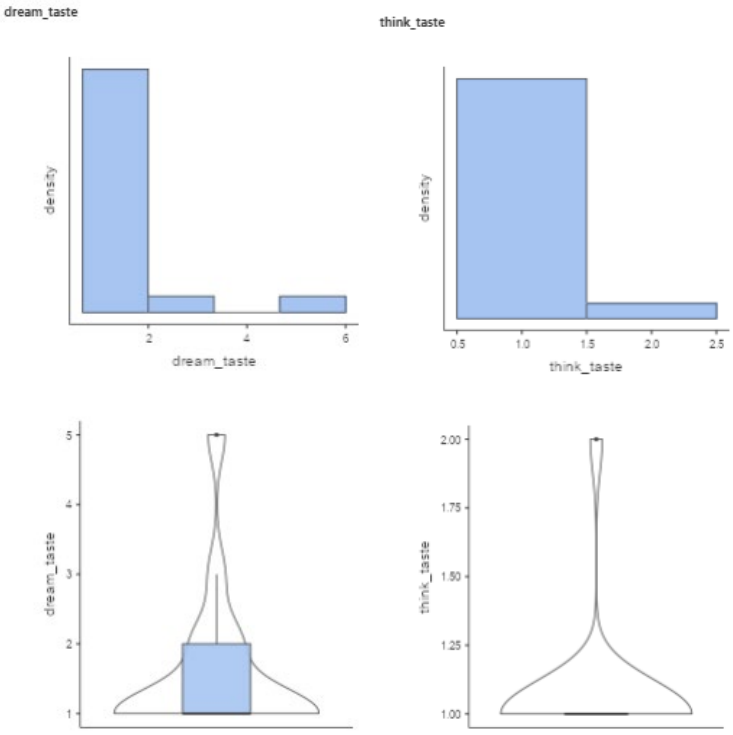
density
happiness_taste
density
fear_taste
love_taste
happiness_taste
fear_taste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think_taste
density
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2.0
2.5
think_taste
dream_taste
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think_taste
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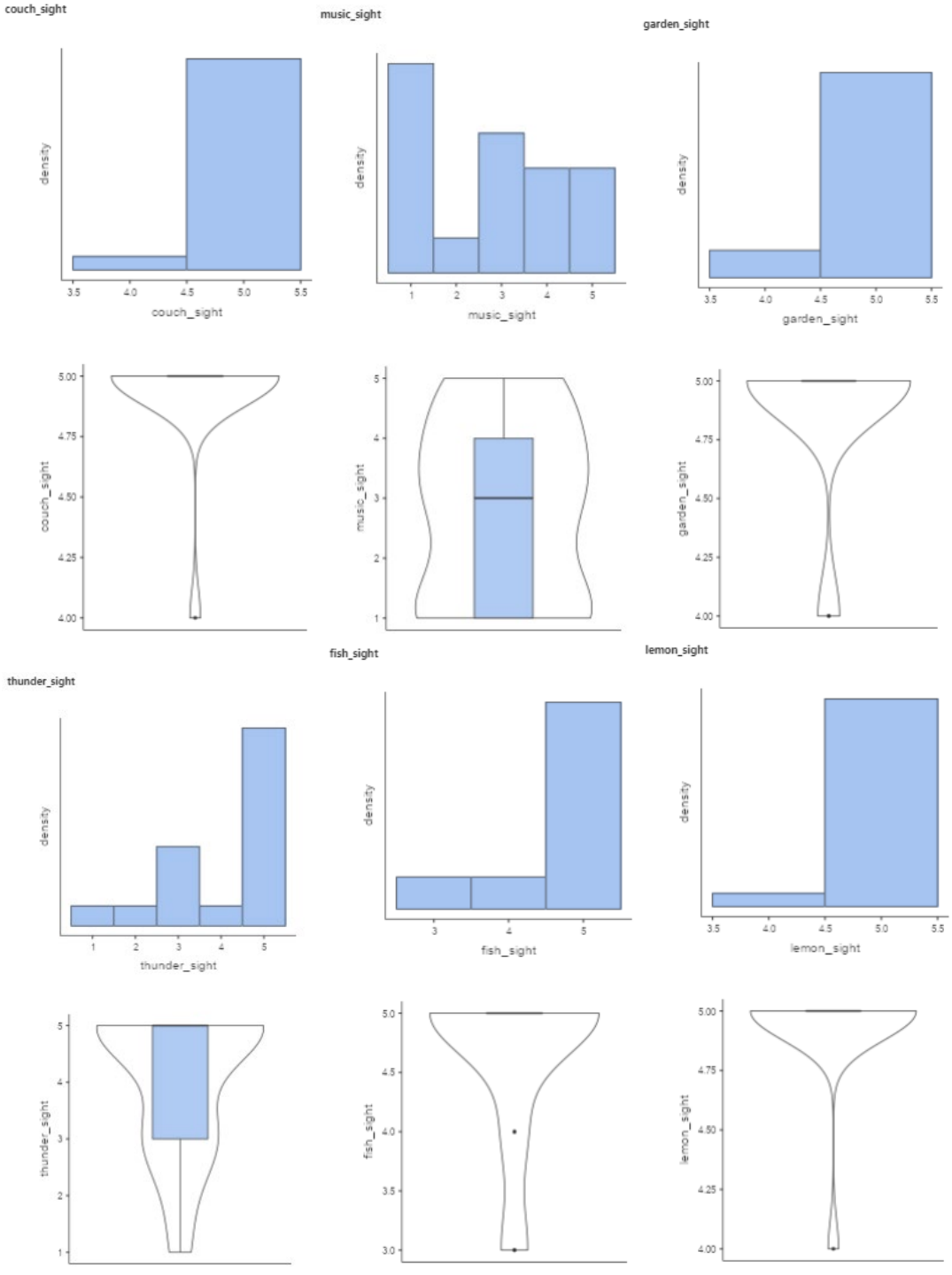
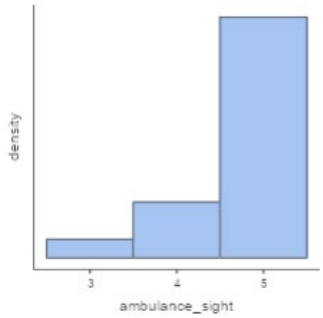
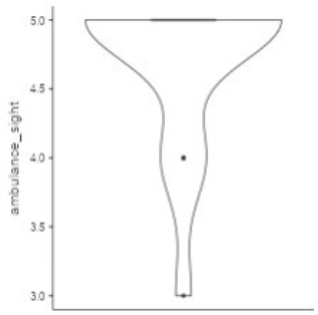
1.75
1.50
1.25
1.00

Appendix *Dispersion of means for concrete and abstract words for sight*

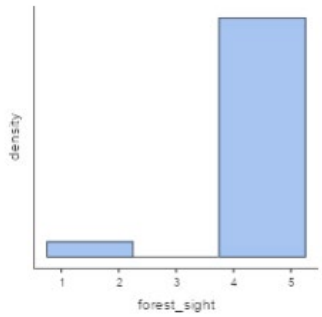


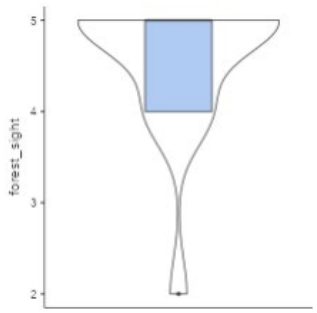
ambulance_sight



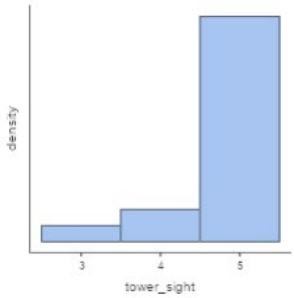


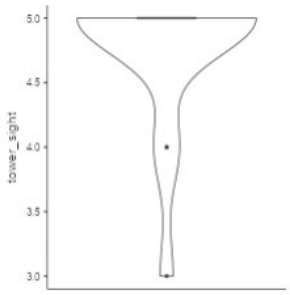
forest_sight



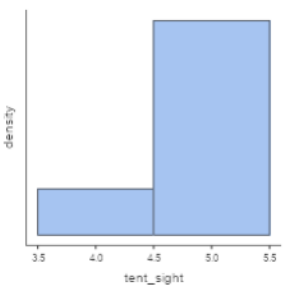


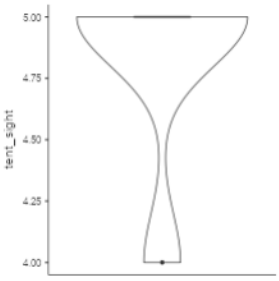
tower_sight



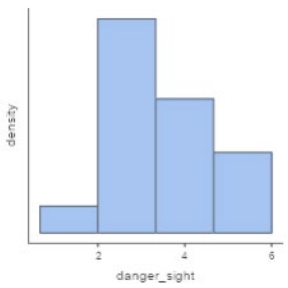


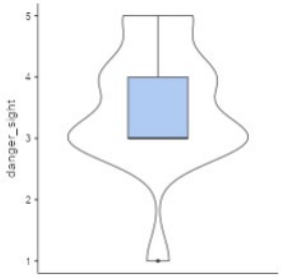
tent_sight



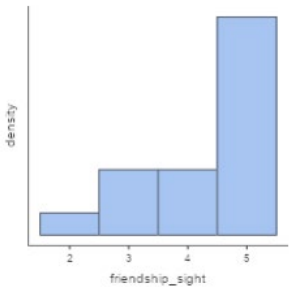


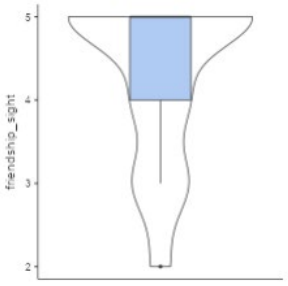
danger_sight

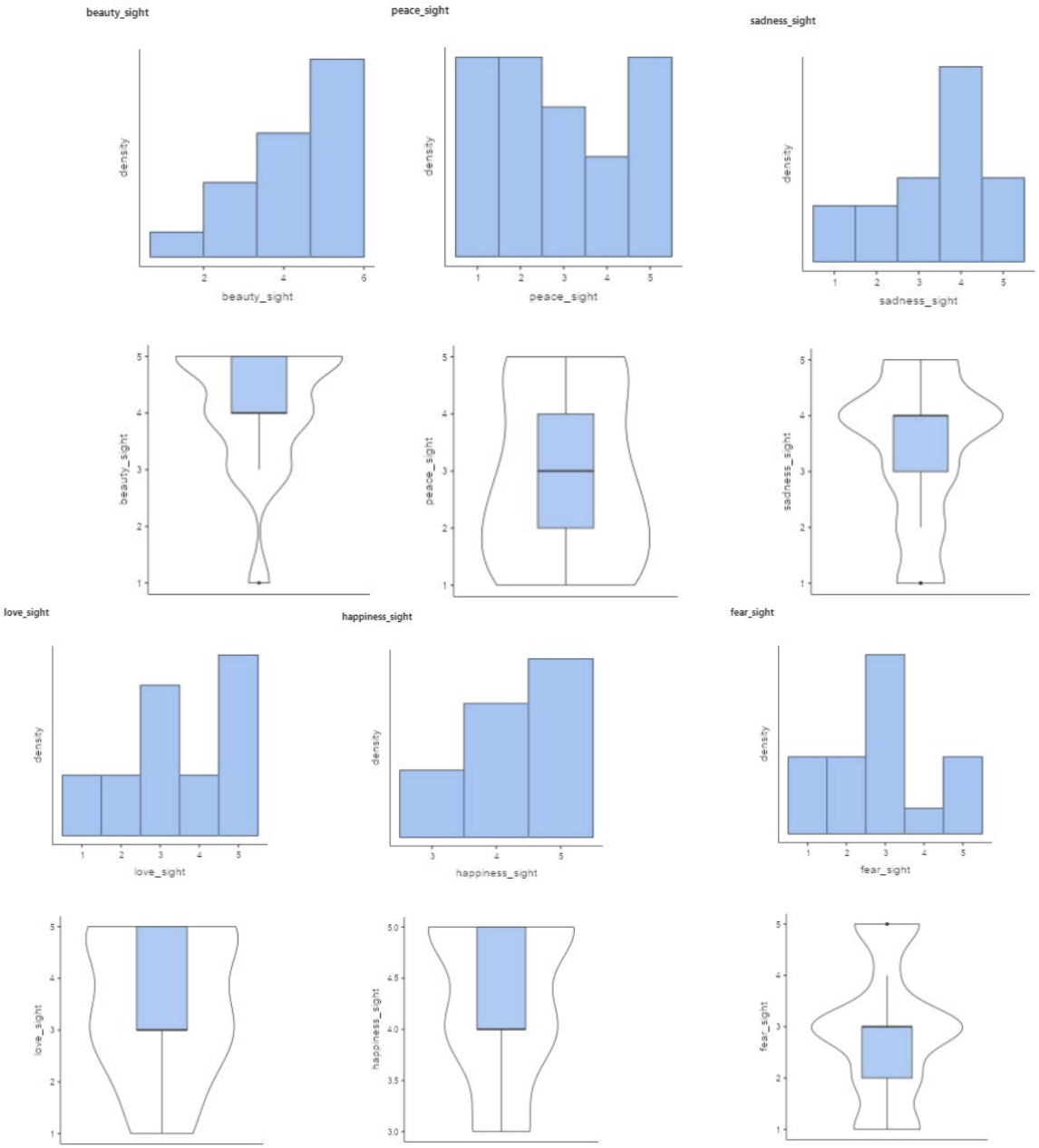




friendship_sight



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beauty_sight
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peace_sight
sadness_sight
density
sadness_sight
beauty_sight
peace_sight
sadness_sight
love_sight
happiness_sight
fear_sight
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happiness_sight
density
fear_sight
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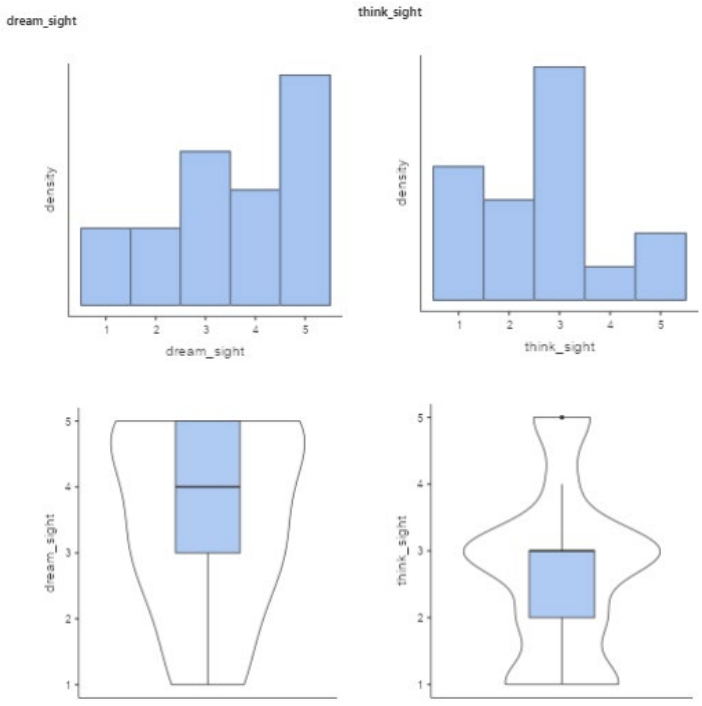
happiness_sight
fear_sight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think_sight
density
density
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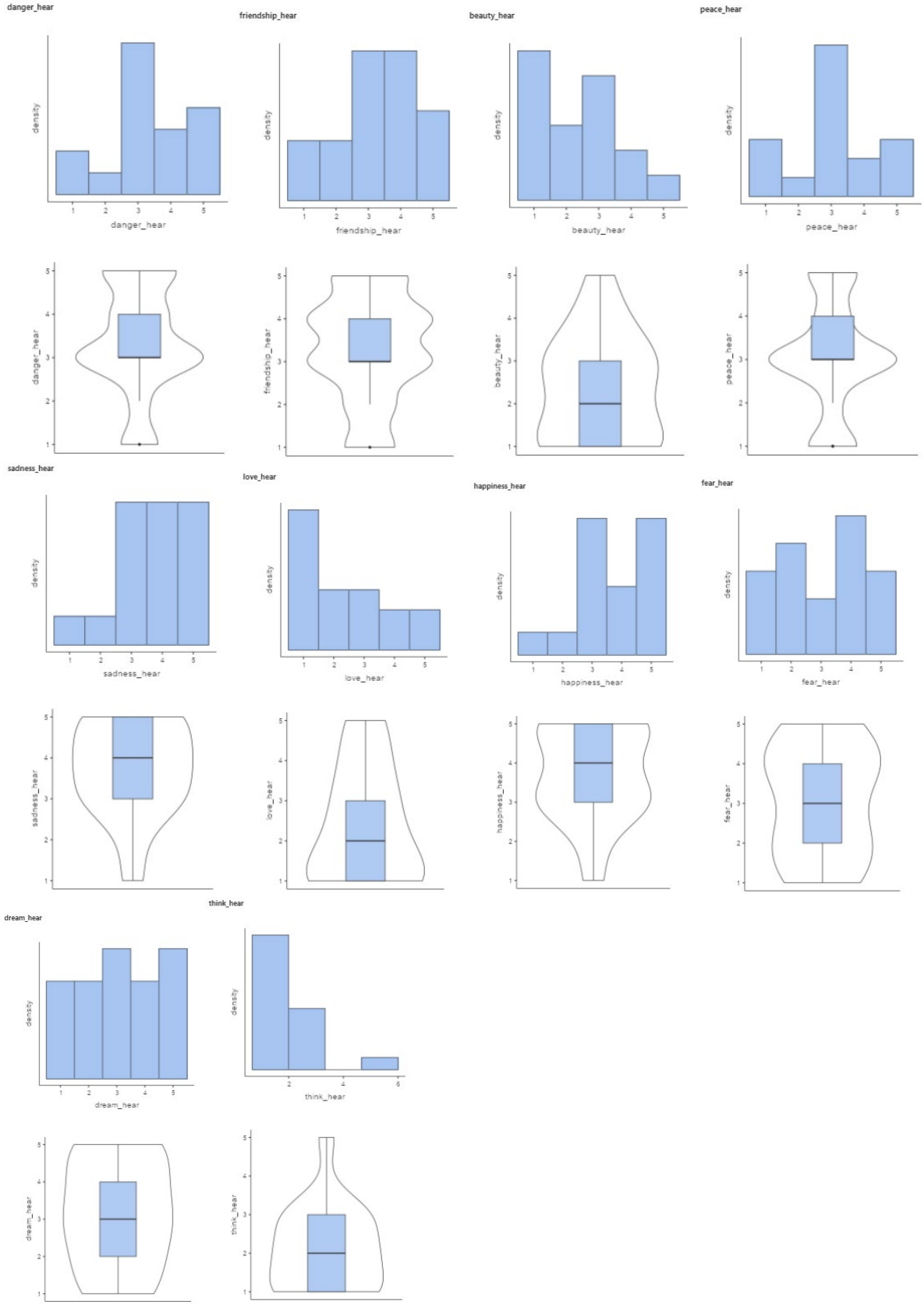
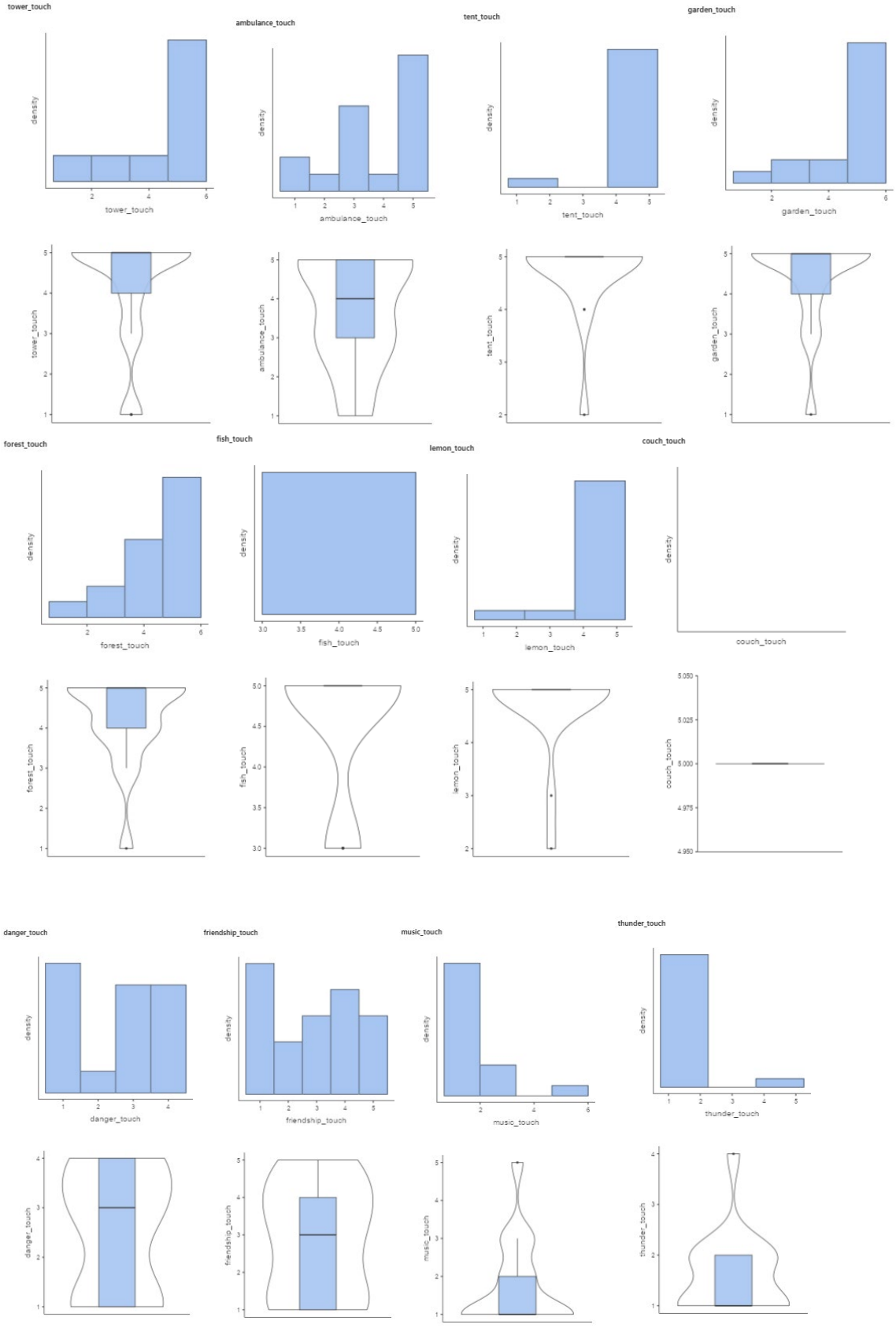
3
4
5
dream_sight
think_sight

dream_sight
think_sight
5
4
3
2
1

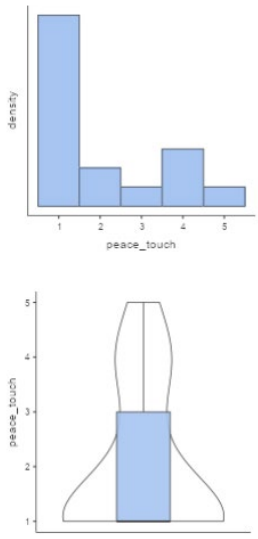
Appendix: *Dispersion of means for concrete and abstract words to hear*



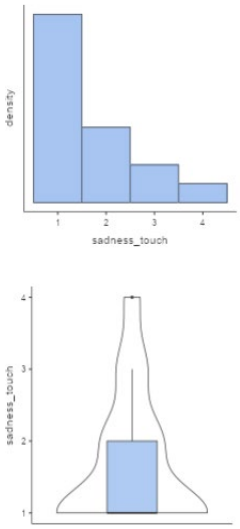
Appendix *Dispersion of means for concrete and abstract words for touch*



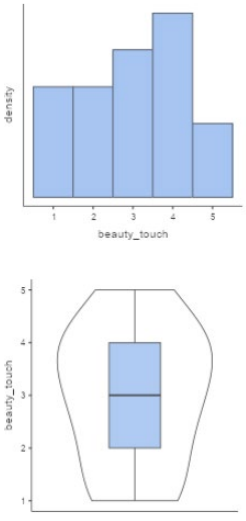
peace_touch



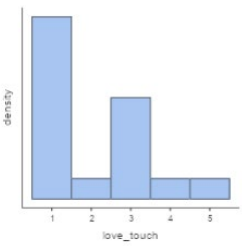
sadness_touch



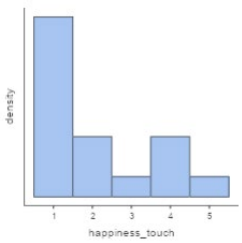
beauty_touch



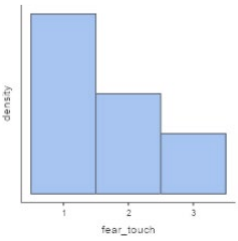
love_touch



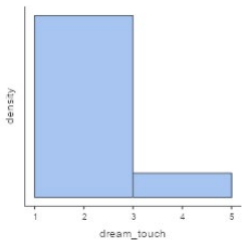
happiness_touch

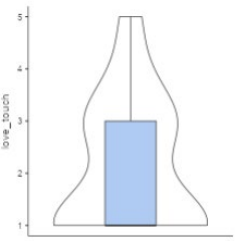


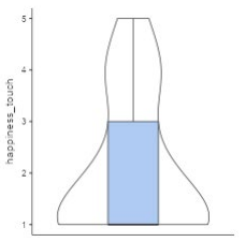
fear_touch

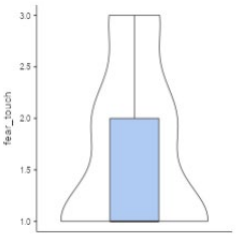


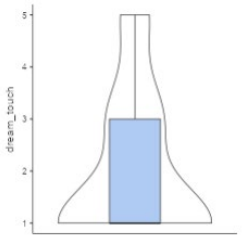
dream_touch











think_touch