ON THE UNIVERSALITY OF COGNITIVE BIASES IN NATURAL LANGUAGE: THE CASE OF NOUN PHRASE INTERNAL ORDERING

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İSTANBUL, 2023

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SUBMITTED TO GRADUATE SCHOOL OF SOCIAL SCIENCES

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

IN

DEPARTMENT OF COGNITIVE SCIENCE

YEDİTEPE UNIVERSITY

GRADUATE SCHOOL OF SOCIAL SCIENCES

İSTANBUL, 2023

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13.06.2023

Sunay AKYÜREK

ABSTRACT

The present study experimentally investigates the order of NP-internal modifiers in gesture modality as practiced by Turkish speaking participants in an attempt to understand the natural order within NPs cross linguistically, whether the participants' preferences reflect a homomorphism bias, and whether their preferences are influenced by their native language. For these purposes, Turkish-speaking participants (N=44) randomly assigned to two conditions where access to their native language was suppressed in the first block (suppression-first condition) or where access to their native language was suppressed in the second block (no-suppression-first condition). Under both conditions, the participants were asked to improvise gestures to describe visuals showing geometric shape clusters varying in distance, number and features. Results of the experiment indicate that the majority of gesture strings produced by Turkish speaking participants is homomorphic and the mostly preferred NP internal order is Dem<Num<N<Adj which implies that the NP internal order preferences of Turkish speaking participants are not directly influenced by the surface structure of NP order in spoken Turkish.

Keywords: gesture, homomorphism bias, native language, NP internal order, surface structure of NP, suppression

ÖZET

Bu çalışma ile Türkçe'de ad öbeklerinin içindeki doğal sıralamasının ne olduğunu, Türkçe konuşan katılımcıların tercihlerinin bir homomorfizm eğilimi yansıtıp yansıtmadığını ve tercihlerinin anadillerinden etkilenip etkilenmediğini görmek için ad öbeği iç dizilim tercihlerini jest modalitesinde deneysel olarak gözlemlemek amaçlanmıştır. Bu doğrultuda, Türkçe konuşan katılımcılar (N=44), birinci blokta ana dillerine erişimin engellendiği (bastırmanın önce geldiği koşul) veya ikinci blokta ana dillerine erişimin engellendiği (bastırmanın sonra geldiği koşul) olmak üzere iki koşula rastgele atanmıştır. Her iki koşulda da, katılımcılardan mesafe, sayı ve özellik bakımından değişkenlik gösteren geometrik şekil kümelerine ait görselleri tarif etmek için doğaçlama hareketler yapmaları istendi. Deneyin sonuçları, Türkçe konuşan katılımcılar tarafından üretilen jest dizilerinin çoğunluğunun homomorfik olduğunu ve ad öbeği içinde en çok tercih edilen dizilişin Dem<Num<N<Adj olduğunu göstermektedir; bu, Türkçe konuşan katılımcıların ad öbeğinin içindeki dizilişe dair tercihlerinin doğrudan Türkçe ad öbeklerindeki temel dizilişten etkilenmediğine işaret etmektedir.

Anahtar Kelimeler: ad öbeği iç düzeni, ad öbeği yüzey yapısı, ana dil, bastırma, homomorfizm eğilimi, jest

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to my supervisor Assistant Prof. Dr. Serkan ŞENER, and co-supervisors Assistant Prof. Dr. Burcu ÜNLÜTABAK and Assistant Prof. Dr. Pınar UĞURLAR for their continuous guidance, encouragement, and feedback throughout the research. I am also extremely grateful to my committee member Prof. Dr. Mine GÜVEN for her valuable comments and suggestions.

I would like to extend my sincere thanks to my dear friend Assistant Prof. Dr. Serkan UYGUN for guiding and supporting me in the statistical analysis of this study. I am also thankful to dear Zühal Zehra OKYAY for assisting me through the challenging and rigorous coding process of this study.

I would be remiss in not mentioning dear Hande GİRAY and Damla ERKİNER who believed and supported me from the begining to the end of this study.

Lastly, I am grateful to my beloved daugher Begüm and my family; this endevour would not have been possible without them.

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1. INTRODUCTION

Typological studies on natural languages reveal some remarkable and striking similarities hidden in linguistic diversity. One of the main issues discussed in the field of linguistics for many years is whether certain commonly observed structures in the world's languages reflect some of the universal features of human cognition. Traces of the fact that languages have universal features despite their apparent diversity have been displayed, among many others, through *noun phrase* constructions (henceforth, NPs). NPs are constituents in a language which in its simplest form contain a noun (NP → N), although they can in principle be more complex with the addition of a determiner as in "a/the/that/these cat(s)" (NP → Det N), an adjective as in "black cat" (NP → A N), or a numeral as in "three cats" (NP → Num N). All these modifiers may appear within a single NP as in English "those three black cats", which is represented by the structure NP → Det Num A N (see Carnie, 2012 for an introduction to the syntax of nouns phrases, and the discussion in Section 1.2 where in more recent literature the NP-internal structure is argued to be strictly hierarchical). Both common and idiosyncratic properties of the structure of NPs in languages beyond English have been a prolific domain of syntactic studies focusing on typology (cf. REFS). Furthermore, the study of these constructions has also become a field of intense empirical investigation in an attempt to have an understanding of what kind of clues noun phrase internal ordering might potentially yield about human cognition in general.

1.1. Language Universals and Universal 20

A seminal typological study on similar linguistic structures attested in the world's languages is Joseph Greenberg's book from the 50s, *Language Universals*[1]. After laying out surface structure similarities across 30 natural languages, Greenberg puts forth generalizations on word order, syntax, and morphology. One of the syntactic generalizations he established is known as the Universal 20, which is about the internal syntax of NPs, and it is stated as follows: "When any or all the items (demonstrative, numeral, and descriptive adjective) precede the noun, they are always found in that order. If they follow, the order is either the same or its exact opposite. (Greenberg, 1983)

Though well-respected and widely cited, Greenberg's study on language universals has been subjected to criticism, mainly for reasons of the sampling size of the study and the kind of reductionist approach taken in the making of the generalizations (Evans & Levinson, 2009). The Universal 20, in particular, has not been exempt from such criticisms either, which will be briefly discussed in the following paragraphs.

1.2. Typological Studies on NP Internal Order

Cinque's (2005) paper on the subject of language universals is arguably the most important study forty years after Greenberg's iconic study on the same subject. The findings of Cinque's typological work on the world's languages have aspects that both support Greenberg (1983) and conflict with it (Cinque, 2005). Cinque stresses that of the 24 mathematically possible NP-internal word orders, only 14 seem to be attested in the natural languages. Adopting a generative syntactic approach along the lines of Kayne (1994) in particular, Cinque assumes that the most common linear orders attested in the world's languages, which was stated previously in Greenberg's Universal 20, is

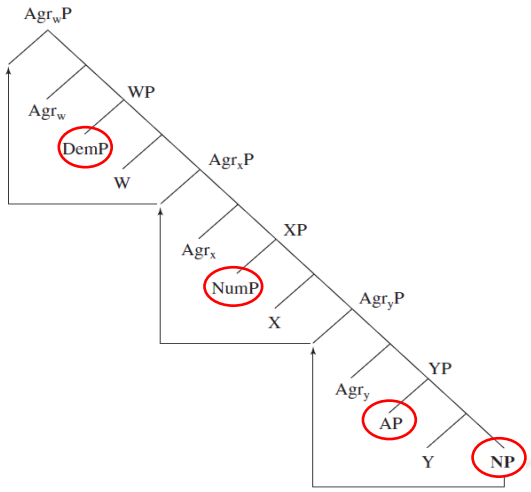
[1] Language or linguistic 'universals' are patterns that systematically observed across natural languages. Findings of research conducted in this field is thought to shed light on cognition, perception, and other abilities of mind. Language universals are categorized under two categories: absolute universals (vs. statistical- or tendencies) and implicational universals (vs. non-implicational). Joseph Greenberg's forty-five language universals basically deal with typology, syntax, semantics.

a mapping of a certain hierarchy in which each NP-internal unit is identified as a phrase in itself, where the demonstrative (now, demonstrative phrase = DemP) dominates number (now, number phrase = NumP), which in turn dominates adjective (now, adjective phrase = AP), and DemP, NumP and AP are all higher in the structure than the head N (noun) that they are in a relation with. The specific hierarchical structure of the extended NP projection adopted from Cinque (2005, 317) below is based on certain key assumptions from Kayne (1994), where hierarchical structuring of all languages is universally right-branching. This entails that no left branching languages exist, at least on a theoretical level, and all languages that "superficially" give the impression that it has a left-branching structure are derived via leftward movement of constituents from a right-branching hierarchical structure. Kayne's (1994) theory of antisymmetry dictates that linear order is a direct mapping of hierarchical structure, and therefore any change in the structure, say, via leftward movement operations, naturally brings about a direct change in the linear order of constituents.[2]

[2] Kayne (1994) presents a challenge to the standard approach taken within the Chomskian tradition of generative syntax, namely that syntax (which is characterized by the hierarchical structures) is *symmetric*, unlike linear order, which is a matter of externalization of language, in that mental objects need not be linearized (dominance relations are sufficient), and yet production requires hierarchical objects to be turned into linear objects so that they can be pronounceable. So, for Chomsky and his followers linear order is not an integral part of syntax, whereas for Kayne (1994) linear order relations cannot be teased apart from hierarchical relations, and thus the syntax per se should also be asymmetric. We will not go into further details of such theoretical issues as they are not crucial for the purposes of the present thesis.

Figure 1

Extended projection of N



The potential NP-internal order is then derived from the uniform structure given above through leftward movement operations. If, for example, no movement of NP takes place, the linear order that the hierarchical structure in (1) dictates is *Dem* < *Num* < *A* < *N* (note that the symbol "<" indicates the precedence relation among linearized units). If, however, the NP undergoes a leftward movement operation all the way up to the specifier position of the Agr$_w$P as indicated by the upward directed arrow in (1), then the resulting structure derives the linear order *N* < *Dem* < *Num* < *A*. Cinque (2005) proposes that the 14 NP-internal linear orders attested in the languages in his survey can all be derived adopting and adapting the Universal 20 and a number of syntactic assumptions he makes.[3] Cinque (2005) argues that his proposal allows him not only to derive the 14 linear orders available in the world's languages but it also makes possible to exclude the 10 sequences that are not attested.

However, based on the findings of his own typological research Cinque states that he is skeptical of the postnominal modifier order within the NP as indicated by the Universal 20 (i.e., the linear order: *N* < *Adj* < *Num* < *Dem*), claiming that it is 'both too restrictive and too permissive'. Cinque points out citing Hawkins' (1983) work that there are languages such as Gabra, Luo and Lugoli (all African languages) that do not

[3] Some of these syntactic assumptions are noted in the main text, but since the details of the proposal are not crucial for our present purposes, we will not articulate them all.

conform to the *N* < *Adj* < *Num* < *Dem* order. As a matter of fact, Hawkins (1983) proposes to revise particularly the second part of the Universal 20 (as suggested in italics below) in light of further evidence as the following: "When any or all of the modifiers (demonstrative, numeral, and descriptive adjective) precede the noun, they (i.e., those that do precede) are always found in that order. For those that follow, no predictions are made, though the most frequent order is the mirror-image of the order for preceding modifiers. In no case does the adjective precede the head when the demonstrative or numeral follow." Hawkins (1983: 119–120). Taking into consideration the observation that certain postnominal orders are unattested, and that the attested orders differ significantly from one another in the percentage of languages that instantiate them, Cinque (2005) rejects Hawkins' revised version of the Universal 20, which actually states that post-nominally anything goes.

Upon conducting a review of the literature on NP typology, Cinque puts the 24 mathematically possible NP internal orders into categories depending on how frequently the order is attested in the world's languages: 'zero (languages)', 'very few (languages)', 'few (languages)', 'many (languages)' and 'very many (languages)'. Cinque's typological study reveals that *Dem* < *Num* < *Adj* < *N* and its mirror image, *N* < *Adj* < *Num* < *Dem*, are the orders observed in 'very many (languages)'. This observation may be taken to make it possible for a speculation that these two mostly attested NP-internal orders in the world's languages might be indicative of a cognitive bias[4]. We will return to a further discussion of this issue later in the thesis.

Another typological study on NPs following Cinque's work is one by Cysouw (Cysouw, 2010). Emphasizing the importance of examining linguistic diversity, Cysouw focuses on noun phrases in the world's languages, and investigates the frequency of attested NP-internal orders. Cysouw (2010) starts by noting that identifying a linguistic feature as 'attested' or 'unattested' is unreliable because that a structure or linear order is unattested does not mean that it is impossible, or that a structure or linear order is possible does not ensure that it will be attested. Cysouw also

[4] Coined by Amos Tversky and Daniel Kahneman (1972), the term 'cognitive bias' refers to the consistent yet flawed tendencies displayed by individuals in their responses to problems related to judgment and decision-making. In language learning, cognitive – or language biases- imply capabilities and limitations of human mind while learning languages.

points out that a particular linguistic structure might not be evident in the group of languages chosen for typological analysis, yet it might be present in another sample of languages; or the specified linguistic structure might not be found in the world's languages today, but it might have existed in the past or may exist in the future.

With these critical remarks in the background, Cysouw (2010) suggests that the focus should be on the "probability of occurrence", rather than on the "possible-impossible" or "attested-unattested". Using a model for NP-internal word order, Cysouw concludes that there is a strong skewness for the frequencies of NP-internal orders and the orders that both Greenberg and Cinque indicated as the ones with the highest frequency.

Explaining this strong preference for the hierarchical structure is difficult for Cysouw as he claims that the suggested structure of NPs is highly sophisticated. He summarizes the characteristics of the most preferred structure adopting a statistical perspective: The first statistical preference observed is that a noun and an adjective tend to be adjacent to each other. Secondly, a noun is located at the boundary of the NP having all the modifiers at either side of the noun together. As for demonstratives, they are preferred to be located on the edge of the NP. Finally, a noun is preferred to be stated before an adjective probably for the purpose of specifying the thing to be modified and then modifying it. In a nutshell, Cysouw's (2010) typological work solidifies the claims that despite several mathematically possible orders that are attested, there is a strong tendency[5] towards NP-internal linear orders that reflect the hierarchical structure. We will turn to details of the hierarchical structure and its relation to linear order below.

In a more recent study Matthew Dryer reports the conclusions of his typological study on NP-internal linear order based on the examination 576 languages (Dryer, 2018). In 113 of those languages in the sample, the linear order *Dem* < *Num* < *Adj* < *N* is attested, while in 182 of them, the linear order *N* < *Adj* < *Num* < *Dem* is the attested one. Dryer (2018) proposes five principles claiming that the extent to which an order conforms to those five principles strongly indicates the frequency of that order. The

[5] In contrast to 'absolute universals', the term 'tendency' implies patterns that may not be true for all languages; however, they are far too commonly observed in languages that they are impossible to be the result of chance.

principles in question are as the following: 'Iconicity Principles (1 and 2)', 'Asymmetry Principle' (3), 'Postnominal Adjective Preference' (4), and 'Intra-categorial Harmony' (5).

Iconicity principles state that when they are all on the same side of the noun, the demonstrative is left out of the adjective and the numeral (principle 1), and the adjective tends to be closer to the noun than the numeral (principle 2). These principles apply perfectly to the NP-internal orders as indicated by Greenberg's Universal 20. According to the *Asymmetry Principle*, the abovementioned iconicity principles bind the prenominal modifiers more strongly than the postnominal modifiers. This principle supports Hawkins (1983) and Cinque (2005) as these typologists claim that postnominal modifier order is not so strict as indicated by Greenberg's Universal 20. *The Postnominal Adjective Preference Principle* postulates that noun-adjective order is favored over adjective-noun order. This principle is in conformation with Cysouw's (2010) observation that the adjective-noun is statistically preferred over the noun-adjective order. Finally, *Intra-categorical Harmony Principle* suggests that modifiers in an NP tend to be on the same side of the noun, which applies for both the *Dem* < *Num* < *Adj* < *N* order and its mirror image *N* < *Adj* < *Num* < *Dem*. Dryer (2018) validates the high frequencies of these two mostly attested linear orders of NP by these principles as each one of those orders are in compliance with his principles.

1.3. Empirical Studies on NP Internal Order and Homomorphism Bias

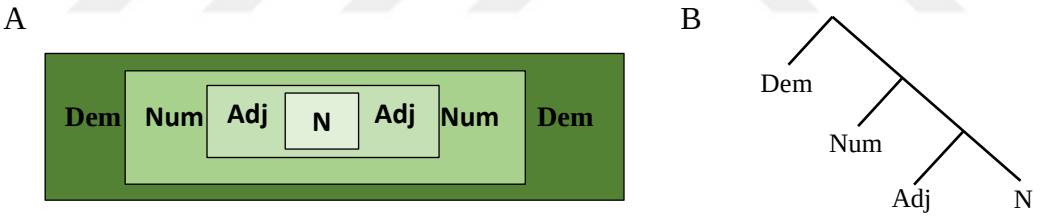
In recent years, a number of empirical studies has been conducted to collect data on the distribution of NP internal elements in an attempt to investigate whether the findings of the typological studies as stated in the Universal 20, for example, are viable.

In an early study, Culbertson and Adger (2014) use an artificial learning paradigm to demonstrate that when learners need to learn a new language under conditions in which the input is impoverished, their learning is based on the knowledge of the hierarchical structure rather than on the surface distribution (i.e., linear order) of elements. In other words, they hypothesize that under such circumstances native speakers disregard surface frequency and benefit from their knowledge of the structures, which are represented in their minds through their native language(s). Before investigating this claim, Culbertson and Adger (2014) capitalize on the linguistic

concept of ‘scope’ in relation to Universal 20 hypothesizing that the NP-internal orders indicated by the Universal 20 are the most attested orders in the world’s languages because an ‘isomorphic’ relation holds between scope and surface order. To explain, first adjectives form structural units with nouns that they modify to exclude numerals and demonstratives. Then numerals are included to create a hierarchically superior unit excluding demonstratives, and finally demonstratives are employed in a further away position to the noun, leading to a syntactically hierarchical structure which is also isomorphic to semantic scope. (See Figure 2)[6]

Culbertson and Adger (2014) label the eight surface orders listed in Figure 3 below as ‘scope-isomorphic linearizations’, which can be derived from the single hierarchical NP structure given in Figure 2B, which Cinque (2005) calls the “base structure”, without disturbing the hierarchical structure. In other words, none of the eight linear orders in Figure 3 is incompatible with the hierarchical structure or semantic scope relations illustrated in Figure 2B.

Figure 2

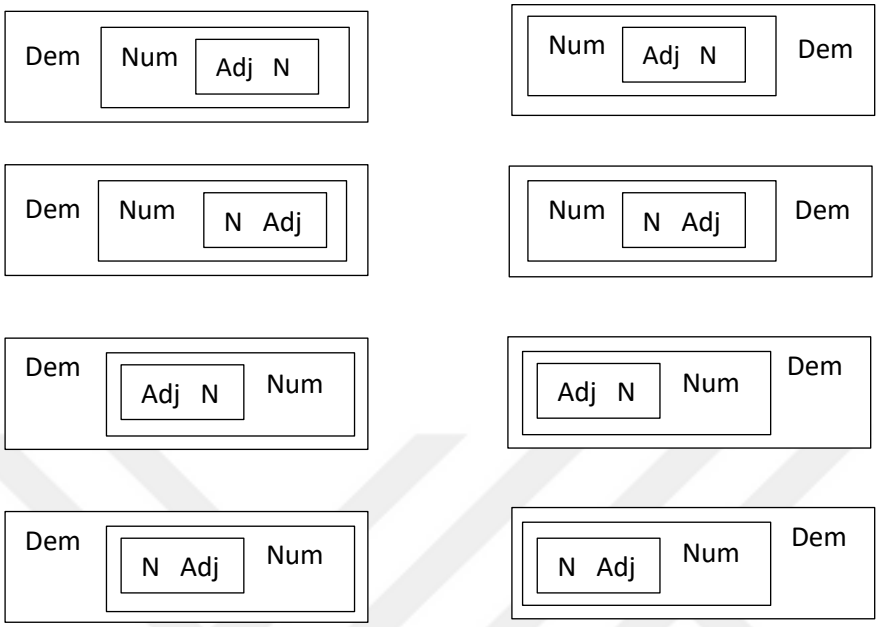


Note. (A) Semantic scope relations in the noun phrase. (B) Hierarchical representation of the semantic scope

[6] As mentioned in the previous chapter on the typology of NP-internal ordering, Dryer (2018) explains this phenomenon with his *Iconicity Principles* 1 and 2.

Figure 3

Scope-isomorphic linearizations



Culbertson and Adger (2014) make the prediction that while learning a new language under conditions in which the input is impoverished, learners will privilege the order that is isomorphic to the scope. Thus, if learners are given, for example, in the input phrases that contain N < Adj and N < Dem, they will arrive at the decision that the order of the modifiers should be N < Adj < Dem which is isomorphic to the scope.[7]

To see whether adult learners' inferences about the NP-internal order in a new language would be driven by the structural or distributional knowledge of their native language, Culbertson and Adger (2014) set up an artificial language learning experiment. In this experiment, learners were exposed to strings from a new language carrying very little information about the NP internal order, hence the input is impoverished. In this new language, in which lexical items from English are used,

[7] Notice that there would be nothing else than Adger and Culbertson's assumption that native speakers capitalize on the semantic scope relation to enforce the learner to end up with the linear order N<Adj<Dem, since, in principle, N<Dem<Adj would also be an option when learners are exposed to N < Adj and N < Dem; as a matter of fact an ambiguity would just be inevitable, which would be expected to show up in the statistical data.

modifiers modify the noun in the postnominal position. Under different conditions, participants who were native speakers of English were exposed to different NPs with a single modifier only, such as ‘vase purple’ (N < Adj) or ‘shoes those’ (N < Dem). Culbertson and Adger (2014) hypothesize that if learners privilege hierarchical structure to make an inference about the linear order within the NP, they should infer the isomorphic order N < Adj < Dem. However, if they prefer to base their decisions on the information provided through the surface structure (i.e., the linear order) of the items presented, they would infer N < Dem < Adj order, which reflects the surface distributional information of the modifiers in their native language, English. The results of the experiment indicate participants’ preference for the scope-isomorphic linearization over the surface distributional information of the language they speak.

Following Culbertson and Adger (2014), Martin et al. (2019) proposed to first replicate the original study, and then to extend it to the speakers of another language, namely Thai. Martin et al. (2019) opted for Thai mainly to extend Culbertson and Adger’s (2014) study to speakers of a language whose NP-internal order is isomorphic, and yet has post-nominal order (i.e., the mirror image of English). Martin et al. (2019) predicted that when exposed to the pre-nominal version of Thai under the condition of impoverished linguistic input, speakers of Thai would more strictly opt for a pre-nominal isomorphic order as the pre-nominal modifier order is “stricter” compared to post-nominal modifier order.

Martin et al. (2019) replicated Culbertson and Adger’s (2014) original study using identical lexical items. The design had a training phase where English-speaking participants were trained on a new language in which nouns are post-modified, and a testing phase where participants were asked to induce the rule for post-nominal NP ordering, and their preference for isomorphism was tracked. The results of the replication study verified the findings reported in Culbertson and Adger (2014). Although there was no explicit teaching of NP-internal order in a new language, the English-speaking participants consistently preferred isomorphic orders for the modifiers given. This conclusion strengthens the hypothesis that English speakers use their knowledge of underlying hierarchical structure of NP instead of the information provided by the surface distribution of elements.

In their extension of Culbertson and Adger (2014), Martin et al. (2019) taught speakers of Thai, a post-nominal language, a new artificial language, which is pre-nominal. The design of the study was the same with the experimental design of Culbertson and Adger (2014) and the design of Experiment 1. The Thai-speaking participants were randomly assigned to an experimental condition where they were trained on a noun phrase (Dem<Adj, Dem<Num or Num<Adj). In Experiment 2, Martin et al. found that when trained on a new language with pre-nominal modifier order, speakers of a language with post-modifier order opted for isomorphic orders. Moreover, the preference for isomorphism was stronger in the pre-nominal artificial language condition compared to the post-nominal artificial language condition. This supports Cinque's (2005) hypothesis that the proposal of Universal 20 on post-nominal orders needs to be revised since it has been challenged by several languages.

In a later study, Martin et al. (2020) pointed out to a limitation of their 2019 study, namely that the Thai-speaking participants may have appealed to a strategy they called "flipping", which may have tainted the results of the study. Thus, they suggested making 'substantial changes' to the task to eliminate the possibility that the participants who speak a post-nominal language simply flip the order in their language to induce the order in a pre-nominal language.

To eliminate the problematic strategy of flipping and to validate the findings of their previous study, they conducted a new study appealing to once again the artificial language learning paradigm (Martin et al, 2020). In their paper, Martin et al. coined the term 'homomorphism' and drew a clear distinction between the terms 'isomorphism' and 'homomorphism'. According to Martin et al. (2020), the term 'isomorphism' is strictly limited to the hierarchical structure of the NP (see Figure 1b), which produces the following two linear orders since the exact hierarchical relations among the modifiers are maintained in these orders: Dem<Num<Adj<N, and its mirror ordering N<Adj<Num<Dem. However, it would be more plausible to name the orders such as Dem<Num<N<Adj as 'homomorphic' since mirroring the order does not produce the same underlying structure.[8]

[8] Notice that those orders identified as "homomorphic" by Martin et al. (2020) were previously in this thesis classified as "scope-isomorphic linearizations" (see Figure 3). We will use the term "homomorphic" from this point on.

To eliminate the flipping-strategy, which English and Thai speaking participants may have used to infer the NP order in new post-nominal and pre-nominal languages, respectively in their previous study, Martin et al. came up with an artificial language named “Nápíjò” with seven lexical items, which have no orthographic or phonetic resemblance to English words. Three of these new words were nouns, which meant *feather, mug* and *ball*. There were two modifiers as Adjectives (*red* and *black*), two modifiers as Numerals (*two* and *three*) and two demonstratives showing distal and proximal positions. The participants were expected to infer the linguistic categories from visual stimuli of a girl standing behind a table demonstrating an object (feather, mug or ball) with some features (red or black) in different quantities (two or three) located near or far (this / that or these / those). The experiment was composed of training and testing phases, with an extrapolation to two modifiers block at the end. In the noun-training block, the participants were trained on nouns using visual stimuli of the objects and then tested on them. In the noun-modifier training block, the participants were trained on nouns modified by either of the two modifiers (an adjective or a demonstrative) by being exposed to visual stimuli of a girl pointing at a feather far away, meaning ‘that feather’ or a girl standing motionless behind a table on which is a red feather, meaning ‘red feather’. The participants were exposed to the NPs describing the visual stimuli both auditorily and orthographically. They were then tested on those visuals and NP descriptions by being given a visual, and choosing the matching description from the given two descriptions. In the critical testing phase, on each trial, a visual with two potential descriptions - one homomorphic (e.g., N<Adj<Dem) and one non-homomorphic (e.g., N<Dem<Adj) - were given and the participants were expected to prefer one. The results of the study once again indicate a preference for the homomorphic orders in the NP with some orders being more notably preferred over some others. For example, N<Adj<Dem is clearly preferred over N<Dem<Adj while there is no preference difference between N<Adj<Num and N<Num<Adj.

It is worth noting here that Experiment 2 by Martin et al. (2020) was a production task. The participants were trained on the same nouns and tested on them in a way identical to Experiment 1. Although the noun-single modifier training was also the same as that in Experiment 1, the testing phase required participants to produce phrases to describe visual stimuli. Following this phase, participants took a comprehension test where they were given two images and listened to one Nápíjò

phrase. Upon hearing the noun phrase, they had to choose the correct image depicting the phrase. The final block of the experiment was the phase that involved two modifiers, where the participants were exposed to images that required them to describe by producing a two-modifier noun phrase. The findings of the experiment clearly indicated a homomorphism bias in all conditions when the participants were to produce the noun phrases. Having eliminated the problematic strategy of flipping from their design and integrated a production phase, Martin et al. (2020) concluded that when exposed to a new language, learners rely on the universal hierarchical structure of the noun phrase, not on the linear order options that their native language exhibits.

Building on the results of artificial language studies on NP internal order, Culbertson Schouwstra and Kirby created a paradigm to inquire whether the mostly attested NP-internal orders are also observed in improvised silent gestures (Culbertson et al., 2020). They hypothesize that when English-speaking participants need to improvise gestures, the order of their gestures tend to be homomorphic. In their experiment, twenty English-speaking participants were exposed to a set of stimuli which consisted of geometric shapes: squares or triangles. Those geometric shapes were either striped or spotted and they were in groups of four or five. The stimuli were shown to the participants on two iPads located near and far from the participants, providing participants information about proximity. The participants were told to describe the images (e.g., four spotted triangles located far) using essentially their hands. In total, a set of sixteen images were presented to the participants twice and their gesture strings were recorded and coded as homomorphic or not. As predicted by Culbertson et al. (2020), the gesture strings the participants improvised to describe the images were homomorphic to a large extent, the most adopted orders to describe the images being ‘Dem<Num<N<A’ and ‘Dem<N<Adj<Num’. Culbertson et al. questions the linguistic drive behind these orders and suggests that the orders might be implying phrases such as ‘those four triangles with spots’ or might be corresponding to sentences such as ‘On this iPad, there are four triangles, and they have spots.’ It is crucial here for our purposes that Culbertson et al. (2020) found that the gesture strings are organized largely in a homomorphic manner no matter whether the reasons behind this tendency is linguistic or otherwise, although we will address this issue in the discussion section of this thesis.

1.4. The Goal of the Thesis and the Research Questions

As is made obvious by the review of the literature in the previous paragraphs, this study is about the internal order of NPs, whether a homomorphism bias holds, whether the universal tendencies attested in the order of NP-internal elements is due to linguistic universals or more generally due to cognitive biases.

With the goal of investigating the NP-internal order of linguistic units in a non-verbal modality along the lines of Culbertson et al. (2020), this study sets out to replicate essentially the experimental design adopted in their study, though a modification is proposed in their experimental design with the intention that a potential confound in their study can be averted. The potential confound we point out to in Culbertson et al.'s (2020) study is that they overlooked the fact that native speakers could always resort to their native language during the experiments in the form of inner vocalization. Their experiments being in a non-verbal modality, Culbertson et al. (2020) made no attempt to suppress native speakers' language use during their experiment, and yet some of their participants admitted that the way they gestured might have been influenced by their native language. We have thus added a speech suppression condition to their design, which we have otherwise adopted without any major changes in our experiment. Note that one of the chief reasons why Culbertson et al. (2020) appealed to the non-verbal modality in their study (diverging from the previous studies reviewed earlier) had to do with the fact that they intended to see whether linguistic universals (like that stated in the Universal 20, for example) are responsible for the observed homomorphism tendency within NPs, or some other (non-linguistic) cognitive bias or biases is/are behind it. Using the non-verbal modality, Culbertson et al. (2020) thought they would abstract away from any potential involvement of linguistic universals or biases. Taking for granted, however, the fact that speakers' engagement with their native language never ceases to exist even when they participate in tasks in the non-verbal modality, we decided to incorporate into the experiment a condition in which inner vocalizations of participants are to be suppressed preventing them from drawing on knowledge of their native language while silently gesturing simultaneously. With the goal of eliminating any potential effect of the native language of the participants', this study presents the results of an experimental study on Turkish-speaking participants in a gesture experiment in an attempt to understand the internal order of NPs. This would allow us to see whether (knowledge of) native language has any impact in their gestural

performance in forming NPs. Note that, admittedly, this would still not rule out the possibility for one to appeal to a linguistic universal, such as the Universal 20, in explaining a potential homomorphism tendency, in case it arises. This is because suppressing speakers' "conscious access" to their knowledge of native language may not be sufficient in blocking the intervention of their knowledge of language; perhaps it only suppresses a conscious *access* to it.

In light of the considerations laid out above, this thesis addresses the following questions:

1. Do speakers of Turkish produce gesture orders that are homomorphic when they need to improvise gestural communication for NPs?
2. What is the natural order of a NP when it is non-verbally represented?
3. Is the non-verbal communication of the NP-internal order susceptible to the language a person speaks?

In order to provide an answer to the questions above, we will test the following hypotheses, respectively.

a) Speakers of Turkish will produce gestural counterparts of NPs in homomorphic orders.

b) The natural order of a NP when it is non-verbally represented is Dem<Num<N<A.

c) Turkish, a language with a prenominal homomorphic order, will have no impact on participants' gestural performance in forming NPs particularly when this knowledge of the speakers is suppressed/shadowed. When no suppression/shadowing applies, an effect of the native language in participants' gestural performance in forming NPs will be observed.

Through this experimental study we aim to contribute to the existing literature on the internal order of NPs and the general tendency of homomorphism by adopting a silent gesturing technique, one that minimizes the impact of participants' linguistic knowledge.

2. METHOD

2.1. Participants

Forty-four native speakers of Turkish participated in the study: 22 in the suppression-first condition and 22 in the non-suppression-first condition. To prevent any linguistic confounds, bilingual speakers were not included in the study. None of the participants knows any sign language and neither of them reported any problems with eyesight which might affect their performance during the experiment. Data from all participants was included in the analysis.

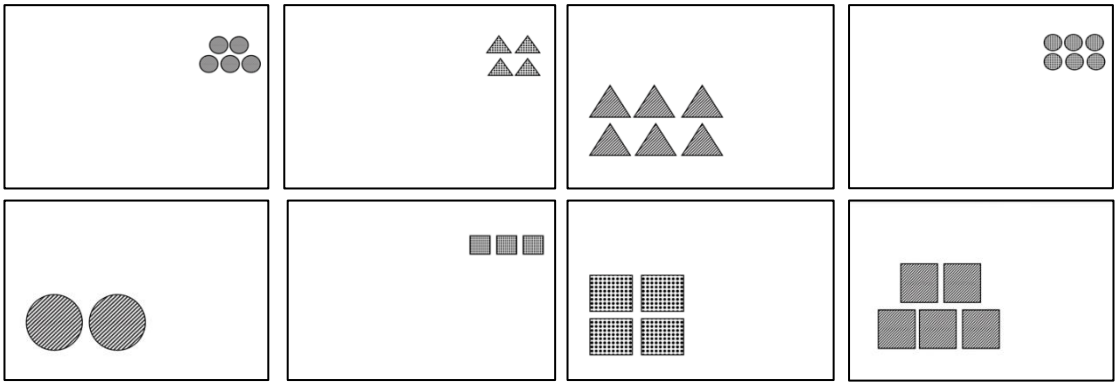
2.2. Visual Materials

A set of images of squares, triangles, and circles (See Figure 4) were used as the stimuli similar to the experiment of Culbertson et al. (2020). The words ‘square’, ‘triangle’ and ‘circles’ were used as the nouns to head the NP, and to be modified by the participants. That the images were selected from either ‘spotted’ or ‘striped’ ones was intended for the participants to modify them using adjectives.

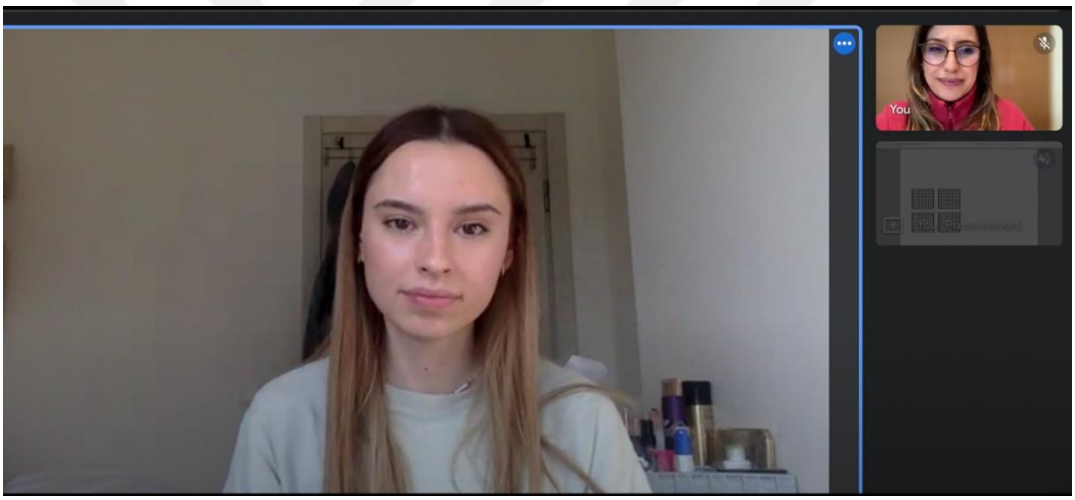
Being presented with squares, triangles and circles in clusters, participants were expected to express numerosity gesturing the number words ‘two’, ‘three’, ‘four’ and ‘five’ to further modify the nouns. To facilitate participants’ gesturing the demonstratives, clusters of shapes were presented in relatively varying sizes and in two positions on the screen: to imply the closeness, clusters of bigger shapes were located to the bottom right of the screen so that participants could gesture the proximal demonstrative of ‘this/these’. Similarly, to indicate further distance, clusters of smaller shapes were positioned on the top left of the screen, which was to encourage participants to gesture the distal demonstrative ‘that/those’.

Figure 4

A



B



Note. (A) Stimulus set for the experiment. (B) Set up of the experiment, with participant and researcher met on Google Meet and images being displayed.

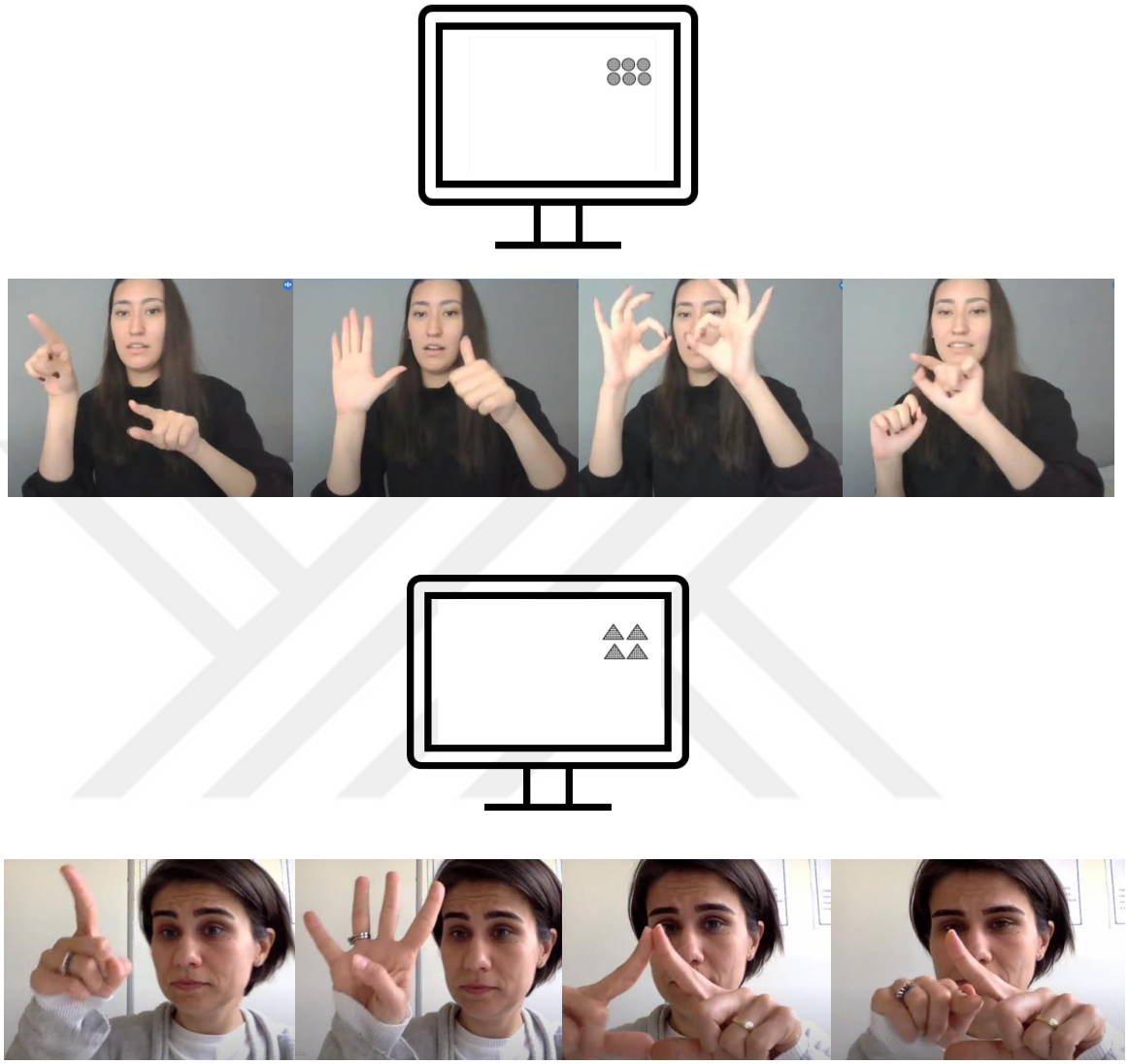
A set of eight shape cluster images was presented to the participants twice, forming a total of 16 images. These visuals were presented to the participants in the same order.

2.3. Design and Procedure

The experiment was conducted remotely on Google Meet due to health concerns caused by the Covid 19 pandemic. For this self-paced study, each participant was randomly assigned to either of the two conditions: Suppression-first (Condition A) or

non-suppression-first (Condition B). Each condition consisted of two blocks, and each block was made of eight trials. The participants were asked to ensure a stable internet connection and sit in a silent room with no distractors. Before the experiment, the participants were briefed about the experiment. They were told that they needed to describe each image they were going to see on the screen using their hands as explicitly as possible so that a person watching them can work out what the participants see on the screen. A brief practice session was employed before participants started the experiment, through which four images of shape clusters were shown to the participants to get acquaintance with the material and gain some fluency in gesturing. Participants were reminded that there was no time pressure, and their main motivation should be to gesture what they see on the screen.

Figure 5



Note. Video clips show two participants illustrating what they see on the computer screen and example gestures. (Top: stimulus *those six spotted circles*, bottom: stimulus *those four spotted triangles*, both participants preferred Dem-Num-N-Adj order.)

In the first block of the non-suppression-first condition (Condition A), the participants were asked to gesture the shape clusters they saw on the screen using only their hands and without speaking. Since this is a self-paced study, participants proceeded to the next image once they finished gesturing the visual. No suppression was invoked in this block, and no action was taken to prevent participants from using

their inner voice. At the beginning of the second block, the participants were exposed to a pseudoword visually on the screen for five seconds and they were asked to gesture the shape clusters they were going to see on the screen shortly using their hands as in the first block and to repeat the pseudoword aloud until the end of the second block. The same images in the first block were shown and they were presented to the participants in the same order as in the first block for coding purposes.

Under the suppression-first condition(Condition B), the order of the blocks in Condition A is simply reversed: the participants of the condition started with the suppression block where they were expected to repeat the pseudoword while gesturing the images they saw on the screen, and they moved on to the no-suppression block where they gestured the images silently. By having two conditions and randomly assigning the participants to these conditions, the effect of learning on the participants' performance was intended to be eliminated.

The performance of the participants was recorded for the coding purposes.

2.4. Coding

Video-recorded gesture responses of the participants were coded by two coders to ensure consistency. The coding strategy used by Culbertson et al. (2019) was adopted and adapted. The gestures were coded into four categories: the gestures indicating the shape were coded as the N(oun), the inner pattern of the shape as the Adj(ective), the numerosity as the Num(eral), and the location of the shape clusters on the screen as the Dem(onstrative). In cases in which participants communicated information that cannot be classified as one of the four modifiers (such as the shape of the screen), they were ignored, remaining true to the coding strategy in the original study. However, some other coding strategies were also needed, which made it inevitable for a divergence from the coding strategies suggested in the original study. Consider, for example, the following gesture sequences which contain repetitive strings (indicated in boldface) as in "**Num<N<Num<N**<Adj<Dem" or "Dem<Num<**N<Adj<N<Adj**", which we assume used by the participants with the "emphasis" function. Such gesture sequences were coded as homomorphic considering that such repetitive strings did not adversely affect it. Also, if a modifier was repeated at the left and right peripheries of a gesture sequence, and when the first use of that modifier or the second use is ignored, if both sequences

remain homomorphic (for example, **Dem**<Num<Adj<N<**Dem**), such sequences were also coded as homomorphic. Moreover, if a modifier was missing in a gesture string (for example, Num<N<Dem) but the sequence was otherwise homomorphic, the string was coded so.

As noted at the outset of this section, gesture responses were coded by two coders. The first coding was done by the author of the thesis, while the second coding was completed by an independent coder. In cases where there was a mismatch between the two coders, the gesture sequence was re-coded by a third encoder following the practice in the original study. Agreement between the coders on gesture order was 93.5% on gesture homomorphism.

3. RESULTS

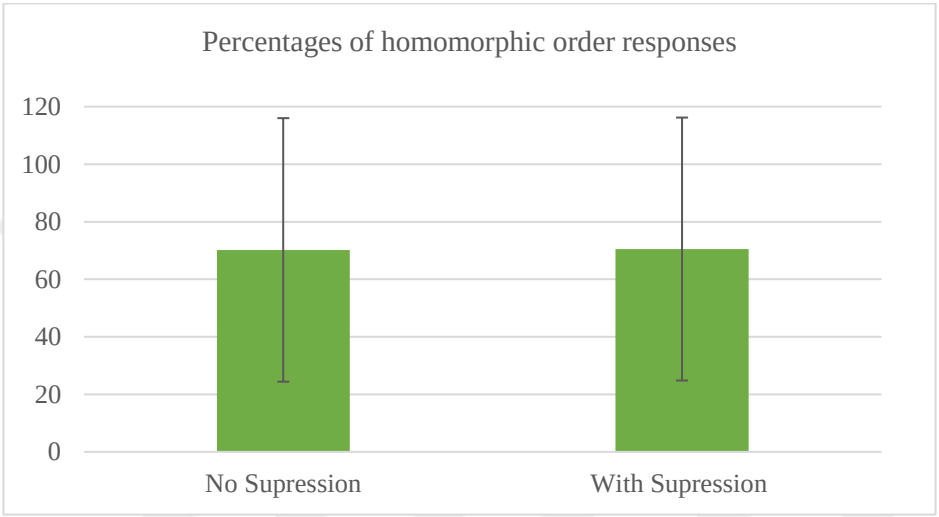
As mentioned in the coding section, responses were binary coded according to two possible output forms, whether the gesture order is homomorphic or not. When a gesture string was homomorphic, the string was coded as '1' and if not, as '0'. In total, six responses were removed before any further analysis: three of them were discarded because the participants' video recordings were difficult to interpret and code due to an Internet connection problem while the other three responses were left out because of an application error. This resulted in a total of 0.85% responses being removed from the whole data set. The remaining data were then analyzed by using R (R Development Core Team, 2017).

A number of statistical analyses were performed on the data. To examine the distributions, means and standard deviations, descriptive statistics were used. To analyze the data, a generalized linear mixed-effects regression model (binomial family, with the bobyqa optimizer) was fitted to the participants' data with crossed random effects by participant and item (Baayen et al., 2008). The model contained the item-level variable 'Condition' (No Suppression vs. With Suppression) as fixed effects. For the random-effect structure of the model, initially a model was constructed with random intercepts and slopes for all fixed effects and when this maximal model failed to converge, we gradually simplified the random-effect structure to reach the best model (Barr et al., 2013). We used the Akaike Information Criterion (AIC) for model comparison, which provides a measure that penalizes complexity and leads to predictors being kept only when they substantially contribute to explaining variance in the data (see Venables and Ripley, 2002). The model with the lower AIC value was selected and this procedure was repeated until the simplification process did not produce a model with a lower AIC. Sum-coded contrasts were employed for the factor Condition when checking for simple effects. The final version of the model included only by participant random slope for condition. The effect sizes are reported by using model coefficients in log odds (β), standard errors (*SE*), and *z*-statistics.

The first research question this study aims to answer is whether speakers of Turkish use homomorphic gesture order when they need to improvise gestural communication for noun phrases. In line with the findings of the original study of Culbertson et al. (2020), the gesture strings produced by the Turkish-speaking

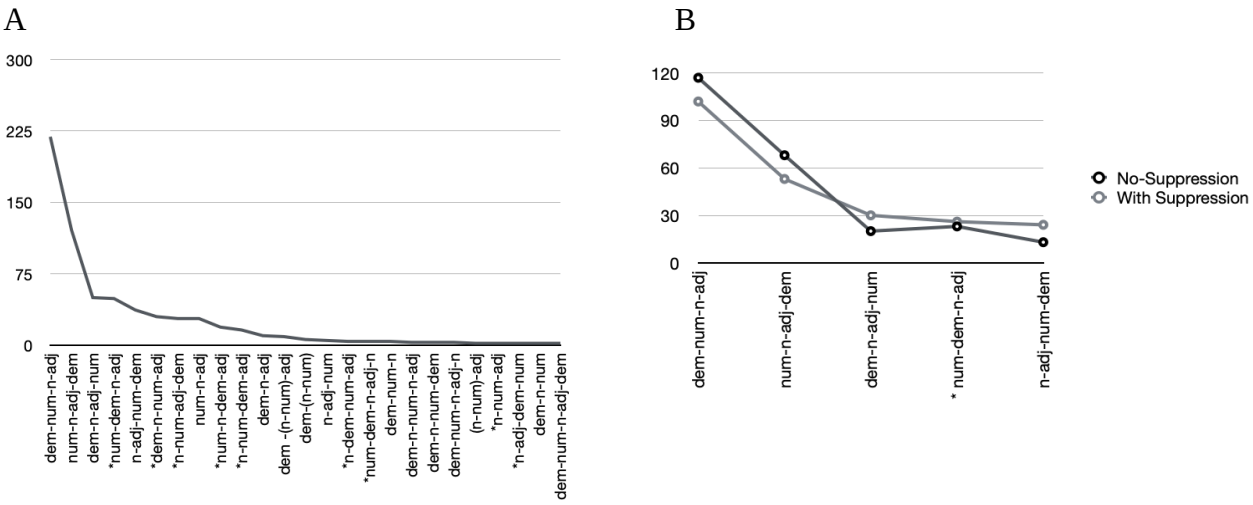
participants of the present study were also homomorphic. As shown in Figure 6, however, the percentage of homomorphic gesture strings under the no-suppression condition was 70.2%, while it was 70.5% under the suppression condition. (no-suppression; $M = 70.2 \pm 45.8$; with-suppression; $M = 70.5 \pm 45.7$)

Figure 6



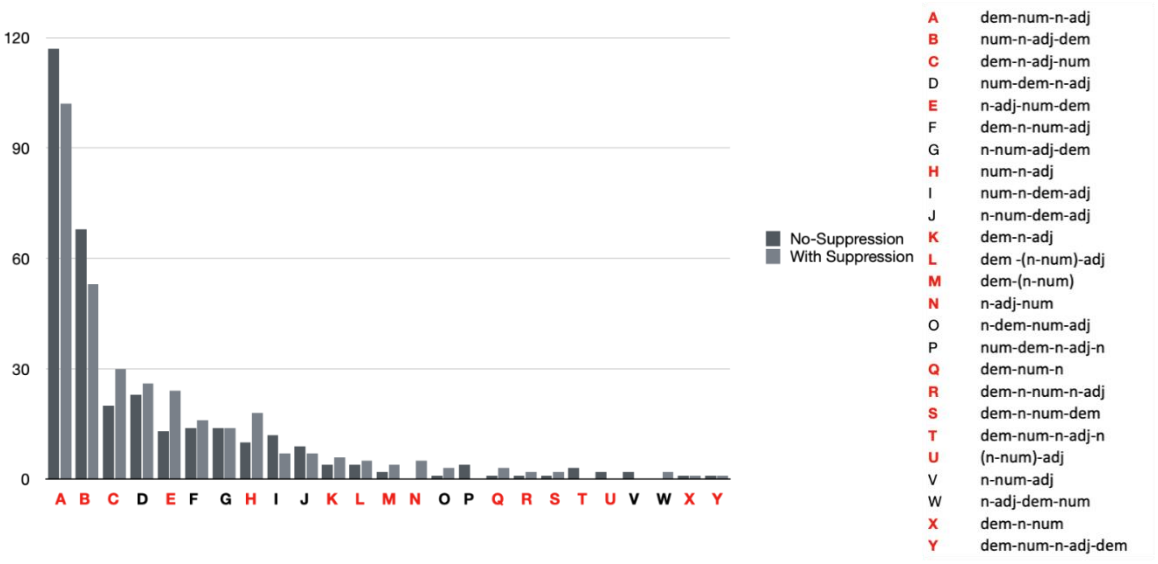
Another research question this study attempts to answer is what the natural order of units in a noun phrase is when it is non-verbally represented. The raw frequency of gesture orders preferred by the Turkish speaking participants is shown in Figure 7 and 8 below. An analysis of the frequencies reveals that **Dem<Num<N<Adj** is the natural order of NP in gestural communication: out of 350 gesture responses, 219 were in this order. The mostly attested order was **Dem<Num<N<Adj** was also found in the original study by Culbertson et al. (2020). However, speakers of Turkish in the present study and the speakers of English in Culbertson et al.'s (2020) study differ in terms of the second mostly attested order. While in the original study **Dem<N<Adj<Num** was identified as the second mostly attested order, in the current study the participants opted for **Num<N<Adj<Dem** as the second most popular order (See 7B). Though they are not identical, the fact that both sequences are homomorphic is worth considering. Also note that the most popular NP-internal order attested in both the original and the current study (i.e., Dem<Num<N<Adj) do not reflect the basic NP-internal order of spoken Turkish and English, which is **Dem<Num<Adj<N**.

Figure 7



Note. (A) The frequency of gesture orders preferred by the Turkish-speaking participants (B) Comparison of the most frequent gesture orders by the Turkish speakers under no-suppression and with-suppression conditions. In both figures, orders preceded by stars are non-homomorphic.

Figure 8



Note. The comparison of raw frequencies of gesture orders produced by the Turkish-speaking participants under no-suppression and with-suppression conditions. Homomorphic orders are indicated by red letter codes; black letter codes are for non-homomorphic orders. All gesture orders produced by the participants in the study (x-

axis), the number of times an order produced by the participants (y-axis). The majority of orders under both conditions were homomorphic; however, the basic NP order in Turkish (Dem-Num-Adj-N) was not produced by any of the participants.

Another question that the participants were asked in the beginning of the study concerned the issue of whether the non-verbal communication of the NP-internal order is susceptible to the language a person speaks. In order to address this question, we suggested integrating a suppression condition to the original design of the experiment laid out in Culbertson et al.'s (2020) study as an extension. The goal of invoking suppression on some participants was to see whether suppressing speakers' (conscious) access to their knowledge of native language would have any impact on the NP-internal orders they would produce. The results of the statistical analysis indicated no significant effect of the suppression condition on the responses of the participants (no-suppression; M= 72.7±44.7; with-suppression; M=63.4±48.2; p = 0.478). The implication of this finding is that speakers who were subjected to the suppressing/shadowing condition (With Suppression Group) displayed a production behavior quite similar to those speakers who were not subjected to the suppressing/shadowing condition (No Suppression Group). In other words, the two groups did not have a major difference in terms of accessing or not accessing to the knowledge of their native language, which was revealed by the observation that their performance in producing (non-) homomorphic gesture orders did not differentiate dramatically.

4. DISCUSSION

Typological and empirical studies conducted on the NP internal order have indicated some tendencies in noun phrase constructions since some orders are noticeably more frequent than others. What these preferences might tell us about human cognition in general will be discussed briefly in this section.

One of the research questions this thesis attempts to answer is whether the speakers of Turkish, a language with homomorphic prenominal NP order, produce homomorphic gesture strings if they are to improvise gestural communication for NPs. The hypothesis we have proposed predicts that speakers of Turkish will produce homomorphic gestural counterparts of NPs. The analysis of data supports our hypothesis: the data from our empirical study suggests that the majority of the gesture strings produced by the Turkish speaking participants was homomorphic regardless of the condition (suppression or no-suppression). Under the no-suppression condition where the participants had no hindrance to resort to (the knowledge of) their native language, the percentage of homomorphic gesture strings was 70.2% while under the suppression condition, the percentage was only very slightly higher with 70.5%. The results suggest that speakers of Turkish have a clear tendency to improvise gestures expressing homomorphic NP orders.

Typological studies focusing on spoken languages indicate that homomorphic orders of NP, which are possible to recover from the underlying hierarchical structure indicated in Figure 2 are more commonly attested in the existing languages of the world when compared to non-homomorphic orders. In line with the typological tendencies in spoken languages, we have found evidence for the Turkish speaking participants to have a robust preference for homomorphic orders of NP when they need to improvise gesture for communicative purposes as four of the top five mostly preferred NP-internal orders being homomorphic as shown in Figure 7 in Results Section (e.g., **Dem<Num<N<Adj**, **Num<N<Adj<Dem**, **Dem<N<Adj<Num**, and **N<Adj<Num<Dem**). In all these orders, the linear proximity of the modifiers to the noun is generally considered to be the indication of the semantic closeness of the modifier to the noun. The results of the gesture experiment in Culbertson et al. (2020) are quite similar to the present study although the proportion of homomorphic gesture responses from the participants in the former study is higher (98% vs. ~70%, respectively). This difference might be explained

by the number of participants; responses from 16 participants were included in the original study by Culbertson et al. (2020), whereas in our study responses collected from 44 participants were analyzed. In both studies, participants' strong preference for homomorphic gesture strings, regardless of their native language, might indicate a cognitive bias. It is clearly not possible, however, to argue that this is a consequence of the fact that the participants' languages both involve prenominal orders of modifiers (i.e., Dem<Num<Adj<N). This is particularly not a reasonable conclusion in light of the findings from both Culbertson et al. (2020) and the present study that the most popular homomorphic orders in gestural communication experiments are not identical to the canonical NP-internal orders in the native languages (English and Turkish, respectively) of the participants. It may be reasonable, however, to conjecture that native speakers of a language with homomorphic NP-internal order relies on the knowledge of the hierarchical structure stated in Figure 2/Figure 3, and this allows (perhaps, forces) them to produce homomorphic orders regardless of whether it is the spoken language or a gestural communication system. As a matter of fact, the suppression condition in the present study was intended to prevent native speakers from appealing to the knowledge of their native language, it turned out however that native speakers of Turkish did not produce at all in the experiment orders that correspond to the NP-internal order of spoken Turkish (i.e., Dem<Num<A<N is missing from the set of orders produced). Crucially, this was also true of those participants who participated in the experiment under the no-suppression condition. In light of these findings we find it reasonable to argue for the validity of one of the following conclusions: (i) the issue of "access to the knowledge of (their native) language" was just not relevant in contrast to what the present study anticipated (as stated through the implementation of the suppression – no-suppression contrast) because the experiment involved a gestural communication task, and being so it just did not tap on such knowledge, or (ii) although the suppression/shadowing task had an impact on preventing participants appealing to their knowledge of language consciously, it was not strong enough a 'barrier' to prevent native speakers' unconscious access to their knowledge of language; in other words, no matter how one tries to suppress one's access to knowledge of language, one can only prevent one's access to explicit processes of production (and perhaps also comprehension) behavior, but blocking access to unconscious knowledge of language is just not possible. We must admit that there is at this point not much unequivocal evidence supporting either of the alternatives mentioned here. Nevertheless, we would

like to discuss each alternative briefly. We will then turn to the question of whether any of the findings of the present study can be used as evidence for either of the alternatives.

If it is the first alternative that we assume to be providing an account for the observed facts, then we are basically taking it for granted that the homomorphism bias is not a consequence of native speakers' linguistic knowledge (i.e., U(niversal) G(rammar) in the sense of Chomsky 1965, 1986, 1995, a.o.), and it follows from the "world" as Culbertson et al. (2020) conjectures. To be more explicit, since the task was not a verbal (linguistic) one but more of a verbally mediated non-verbal task ('silent gesture paradigm' as called by Culbertson et al., 2020), there may be reasons to not expect for native speakers' linguistic knowledge to come into play. The observed homomorphism bias must then be accounted for as a consequence of the way the world is perceived and articulated by humans; Culbertson et al. (2020, 699) suggest "…that objects are more closely associated with their properties than with their numerosities; objects and their numerosities are in turn more closely associated than objects and their location and/or relation to the speaker. *These nested conceptual representations* (*which are not linguistic in nature)* [italics mine, SA], combined with the linguistic categories Noun, Adjective, Numeral, and Demonstrative, form the basis of the hierarchy from which noun phrase linear order is derived." And crucially, they argue on the basis of an information-theoretic measure of strength of association that the NP-internal order may in principle be learnable from observing the world, and it need not depend on innate knowledge of language as suggested in work by Noam Chomsky and others.[9]

If it is the second alternative that we keep to in providing an account for the observed facts, then we would have to assume that native speakers' tacit/innate knowledge of language is what they depend on no matter whether it is a verbal or a non-verbal task. If true, then the lack of any significant difference between the two groups (i.e., suppression and no-suppression) can possibly be interpreted as indicating that

[9] Culbertson et al. (2020) defend their position strongly though not without caveats. They say that "[T]he skewed distribution of orders across languages may thus come from a pressure to be homomorphic combined with a universal hierarchical structure derived (in part) from properties of the world around us." Notice the phrase "in part" in parentheses in this quote; the implication is that it is still safer to leave room for mind-internal, and possibly languages-specific, factors to be a factor in the explanation.

access to linguistic knowledge is just simply impossible to block; it is so deeply rooted that native speakers cannot escape it. This would further imply that the manipulation of the variable “suppression” was in principle futile.

We now turn to addressing the question of whether any of the findings of the present study can be argued to provide support for either of the alternatives. It should be noted at the outset that most findings can in principle be argued to support either approach, so in this respect it is hard to come by evidence that clearly teases the two approaches apart. Thus, we will assume here a weaker position in discussing the findings. Nevertheless, we think that at least a minority findings can be argued to favor one of the approaches over the other.

For one thing, we find it quite striking that 4 of the 5 most frequently gestured orders in our study are homomorphic, and they correspond to the first 4 of the 5 most frequently found NP-internal orders in spoken languages reported in the typological study of Dryer (2018) (cf. Table 1, where red-painted orders indicate those that are homomorphic).

Table 1

Rankings of NP Orders in Typology and Gesture Study

Rank	Dryer 2018	Our Study
1	**N-A-Num-Dem**	**Dem-Num-N-A**
2	**Dem-Num-A-N**	**Num-N-A-Dem**
3	**Num-N-A-Dem**	**Dem-N-A-Num**
4	**Dem-N-A-Num**	Num-Dem-N-A
5	**Dem-Num-N-A**	**N-A-Num-Dem**
6	N-A-Dem-Num	Dem-N-Num-A
7	N-Dem-A-Num	N-Num-A-Dem
8	**Dem-A-N-Num**	**num-n-adj**
9	Dem-N-Num-A	Num-N-Dem-A
10	N-Num-A-Dem	N-Num-Dem-A
11	N-Dem-Num-A	**Dem-N-Adj**
12	**Num-A-N-Dem**	**Dem-(N-Num)-A**
13	**A-N-Num-Dem**	**Dem-(N-Num)**
14	Num-N-Dem-A	**N-Adj-Num**
15	A-N-Dem-Num	N-Dem-Num-A
16	Dem-A-Num-N	Num-D-N-A-N
17	Num-Dem-A-N	**Dem-Num-N**
18	N-Num-Dem-A	**Dem-N-Num-N-A**
19	A-Num-Dem-N	**Dem-N-Num-Dem**
20	A-Dem-Num-N	**Dem-Num-N-A-N**
21	Num-A-Dem-N	**(N-Num)-A**
22	Num-Dem-N-A	N-Num-A
23	A-Dem-N-Num	N-A-Dem-Num
24	A-Num-N-Dem	**Dem-N-Num**
		Dem-Num-N-A-Dem

It is also quite striking a fact that the second most frequent order in Dryer's (2018) corpus, namely **Dem<Num<A<N**, is completely missing in the gesture orders produced by the participants of the present study, despite the fact that **Dem<Num<A<N** is the predominant order in spoken Turkish. Though, somewhat surprisingly perhaps, our participants did not rely on the NP-internal order of their native language in their improvisation of the gestures, the top 5 of their production involved more homomorphic strings than non-homomorphic ones as Table 1 shows above. While the former fact may suggest that the nature of the task (silent gesture paradigm) forced participants to stay

away from their linguistic knowledge (knowledge of native language, in particular), the latter may be interpreted as indicating that the nature of the task did not play a critical role in preventing them relying on linguistic knowledge. One may object that this latter can also be accounted for under Culbertson et al.'s (2020) approach assuming that homomorphic orders are also favored in their framework, though for different reasons from Chomsky's. True, but we would like to emphasize here the fact that 4 of the top 5 gesture orders produced correspond to the 4 of the top 5 of Dryer's (2018) spoken language corpus. That match in frequencies between gesture orders attested in the present study and those of spoken languages is somewhat unexpected given the fact that participants were prompted to use gestures to explain a given scene. There are *at least* 24 different ways to put each relevant item in the scene into gesture orders.[10] Why, of the 24 possible orders, did participants opt for 4 of those that are most frequent in spoken languages? We leave this question open just pointing out to the fact that no such similarity with spoken languages is warranted in a silent gesture experiment, but this is what we observe.

Another observation worth discussing here concerns the most attested of the gesture orders, namely **Dem<Num<N<Adj**. Recall that this is also the most attested gesture order of NPs in the Culbertson et al. (2020) study, which also involved a silent gesture paradigm. First of all, this order does not fully reflect the order of NPs in either Turkish or English, which are the native languages of the participants in both studies, and both languages display **Dem<Num<Adj<N** order within NPs. One wonders why both speakers of Turkish and English dominantly produced the order **Dem<Num<N<Adj** in a gesture experiment. Thinking that gestures form the bases of sign languages, we decided to see if sign languages might have anything to suggest in this matter. In a sense, we explore whether modality might matter on how NP-internal order is organized. In a comparative study on NPs in signed and spoken languages Coons (2022) hypothesizes that the most common language patterns in spoken languages are also common in signed languages, and a comparison of data from the 41 signed languages and the data from spoken languages in the World Atlas of Language

[10] We say "at least" in the main text because, in the gesture paradigm experiments, participants may go beyond logically possible 24 orders by omitting items or by multiplying them. For example, there were cases in the data set where "N and Num" appear as a single gesture, which produce the order Dem<[N+Num]<A with actually three items.

Structures (WALS) reveals similar NP order patterns. Regarding the NP structures of the signed languages included in the same study, **N<Adj** order (with 39%) is more commonly observed than **Adj<N** (with 24.4%), **Num-N** (with 41.7%) is preferred over **N<Num** (with 30.6%), and in one third of the signed languages (with 33.3%), signers primarily use **Dem<N** order. When these binary choices are extrapolated to anticipate NP-internal order from these data, we would arrive at two probable strings: **Dem<Num<N<Adj** or **Num<Dem<N<Adj**. The former order is homomorphic, and significantly the most preferred gesture order in both our study and that of Culbertson et al.'s (2020), while the latter order is non-homomorphic, it is also the fourth mostly preferred order in our study. Coons' (2022) findings on the NP-internal order in sign languages provides a perspective as to how to interpret the dominance of **Dem<Num<N<Adj** among our participants (and those of Culbertson et al.'s, 2020). Simply put, it is possible to conclude that it is a modality effect, although it is worth noting that sign languages are natural languages in all intents and purposes, and yet gestures improvised by non-signing participants in our study can in no way be equated with sign languages.

To summarize, this study has demonstrated that when prompted to improvise gestures in describing a scene, participants with Turkish as their native language, have dominantly produced gesture strings that are homomorphic, and thus replicated the findings reported in another study that used the silent gesture paradigm, namely Culbertson et al. (2020). Unlike Culbertson et al. (2020), the present study attempted to see whether suppressing native speakers' appeal to their knowledge of (native) language would make a difference in the results, but no significant results have been reached between groups whose production was suppressed and those no such suppression was applied. The overall results could in principle be interpreted as what Culbertson et al. (2020) have suggested, namely that the homomorphism bias is one of a (domain) general cognitive tendency guided by humans' interaction with the world. Properties of objects that humans acquire by observing the world might be reflected in semantic scope relations which shape word orders in natural languages. As Culbertson et al. (2020) claims humans might be building semantic relations and might be creating conceptual representations by observing the world, resulting in hierarchical linguistic representations.

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