Original article

# Is syntax innate or acquired: A comparison between Japanese and English speakers' ability to Learn Turkish and Mandarin syntax.

Kusano K

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**Abstract**
Among the nature-versus-nurture debate on language learning is the question that has been a longstanding topic of debate among linguists: is syntax innate or acquired? This study compared Japanese and English speakers' ability to learn Turkish and Mandarin syntax, in concordance with previous studies that used word order as a proxy for syntax. If syntax were innate, both groups would have performed similarly. If syntax were acquired, Japanese speakers would have performed better in learning Turkish, and English speakers in Mandarin, due to syntactic similarities. The findings supported both hypotheses: both groups performed better in learning Mandarin, suggesting that syntax may be innate and that there could be an inherent preference for certain syntactic structures — specifically, subject-verb-object (SVO) syntax over subject-object-verb (SOV) syntax. Conversely, the results also suggested that syntax may also be acquired. Japanese speakers learned Turkish better, whereas English speakers learned Mandarin better. Furthermore, with increased exposure to a greater variety of syntactic structures, all participants performed better. From these findings, it was concluded that both nature and nurture contribute in shaping syntactic use.

**Keywords**
Universal grammar, Grammar, Syntax, Language acquisition, Subject-verb-object, Subject-object-verb, Linguistics, Language development, Grammatical construction, Accessibility hierarchy

Koko Kusano, Crimson Global Academy, 1 Grange Rd, #12-01 Orchard Building, Singapore 239693.
koko.kusano@gmail.com


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## 1. Introduction

If language were never taught to a person, would they produce their own? Further, would they reproduce the language that they had never been taught? In the investigation of this question, the ideal experiment of design may be to “maroon some spare infants on a desert island to see if and how language develops on its own (1).” Realistically, however, such an experiment would undoubtedly be called into question for its lack of ethical consideration. It is worth mentioning though that this ultimate experiment may have been actually performed: Herodotus (B.C. 460) reports that two infants were set apart from adults, but fed, and raised in an isolated cabin. No one was to speak to them on pain of death. The experimenters were an Egyptian and a Phrygian king. Their investigation was designed to resolve the question of which (Phrygian or Egyptian) was the first of all languages on earth. Appropriately enough for kings, the two appear to have been radical innatists, for they never considered the possibility that an uninstructed pair of children might not develop language at all. In the event, Herodotus tells us that these subjects began to speak Phrygian, and there the matter has rested for some millenia (1).

In contrast, other studies of linguistically-deprived children (e.g. feral children) have shown that children do not develop any form of communicative skills in linguistic isolation. It is important to recognize that linguistic isolation often goes hand in hand with social isolation. In social isolation “it would be pointless to externalize the language of the mind if there were no ‘other’ to whom it could be addressed (1).” With this in mind, the ideal experiment for the nature-versus-nurture debate on language learning would then be to have linguistic isolation as the only independent variable.

Many researchers have explored persons subject to linguistic isolation to understand language development, focusing on populations such as deaf children raised without sign language, feral children raised by animals, and children in situations of extreme neglect. These studies have provided valuable insights into the role of social interaction and environmental factors in language acquisition, revealing that while language may not develop in complete isolation, humans appear to have an innate capacity for creating and understanding complex communicative systems. In this regard, Goldin-Meadow et al. worked with congenitally deaf children who had never been exposed to any conventional language model but had an adequate social environment in which they could develop communication skills (2). These children were raised by hearing parents who were only familiar with oral language. Despite their impoverished language-learning conditions, these children had developed their own gestural communication systems called “homesigns” which they used to communicate with their parents. In observing the language they produced, what Goldin-Meadow et al. interestingly found was that these children, though they grew up under parents who homesigned to them differently across households and cultures, produced a similar syntax. In response to this finding, Goldin-Meadow et al. concluded: “If a deaf child is able to produce a grammatical construction without any guidance from a language model, that grammatical construction must be very high on the accessibility hierarchy — what we have called a resilient property of language. Thus, the constructions we have identified in the deaf children's homesign systems are likely to be highly accessible to all language-making children, serving as, what Slobin so aptly called the conceptual starting points for grammatical notions" (2).

Though it is true that there are a variety of syntactic structures in the ~ 6,500 languages that exist in the world, such a finding nevertheless begs the question whether syntax is innate in the nature-versus-nurture debate on language acquisition.

**1.1** *Syntax is innate*

Before delving into this question, it is instructive to mention the person who sparked this conversation. Also known as the father of modern linguistics, Noam Chomsky first introduced his "Universal Grammar (UG)" theory in his books *Syntactic Structures* (1957) and *Aspects of the Theory of Syntax* (1965). He proposed that all humans are born with an inbred ability to acquire, develop, and understand syntax. At large, his argument was based on the nativist "Poverty of the Stimulus" argument (3), as he states: "Any grammar of a language will *project* the finite and somewhat accidental corpus of observed utterances to a set (presumably infinite) of grammatical utterances. In this respect, a grammar mirrors the behavior of the speaker who, on the basis of a finite and accidental experience with language, can produce or understand an indefinite number of new sentences" (4).

In other words, Chomsky's *UG* theory states that people can never be exposed to all possible syntactic variations of a language, making it impossible to draw comprehensive conclusions about its syntactic structure based solely on experience. It is only with an inborn predisposition toward certain word orders that they could distinguish between the correct and incorrect syntactic forms. This inherent bias is what allows people to internalize the structural laws of a language. Another reason for his contention is that grammar is not derived from semantics. To illustrate this, Chomsky contrasts the nonsensical sentences "Colorless green ideas sleep furiously" and "Furiously sleep ideas green colorless," pointing out that any speaker of English will recognize that only the former follows a grammatical system (4). This suggests that syntax is a cognitive system independent of the meaning of words that people acquire through experience, rooted instead in innate mechanisms that allow for intuitive differentiation between correct and incorrect word order.

However, scholars have noted the weakness of Chomsky's *UG* theory that lies in his lack of explanations for the origins of these supposed primitive syntactic categories that, according to him, help people easily recognize the syntactic structure of a language. The innate syntax theory is often subject to the criticism of empiricists who emphasize on falsifiability as well as the central role of attained experiences and observations in the formation of syntactic structures. Accordingly, existing experimental studies that provide empirical evidence for the *UG* theory include the following.

1.1.1 *Behavioral evidence*

Similar to Goldin-Meadow et al.'s study (2), many of the behavioral studies that support Chomsky's UG theory often involve children in their participant pool, as this would logically be the period of a person's lifetime when they would have had the least linguistic exposure and experience which, according to the *Poverty* *of the Stimulus*, could be an indicator of innate syntax if they were to acquire syntax.

Lidz et al. (2003) found that 18-months-old infants could recognize a syntactic structure that they could not possibly have learned (5). According to the corpus, in a large collection of written or spoken language data, the anaphoric phrase "one" appears in conversations only 0.2% of the time. An anaphoric phrase refers to a phrase referring to or replacing a word that was used earlier in a text. With only 18 months of exposure to the English language and barely having begun to say more than one word, it would be highly unlikely for these children to comprehend syntactic structures that consist of this anaphoric phrase. To test this theory, the children were randomly allocated to one of two groups, control and anaphoric. Both groups were first shown a yellow bottle. Then the control group heard the neutral phase: "Now look. What do you see now?" Meanwhile, the anaphoric condition group heard the phrase containing the anaphoric phrase "one": "Now look. Do you see another one?" After which both groups were shown a yellow bottle and a blue bottle. Using an intermodal preferential looking paradigm, Lidz et al. found that at this point the control group looked at the blue bottle instead of the yellow, whereas the anaphoric condition group looked at the yellow bottle with which they were familiar. This suggests that even children at an early stage of syntactic exposure are able to not only understand but also act in line with syntactic structures of their exposure language. Concluding their study, Lidz et al. stated: "This is not to say that there is no role for the input, for statistical learning or for distributional analysis in language acquisition. Rather, in our view, a set of representational presuppositions inside the mind of the learner serves to structure the available input in such a way as to make learning possible" (5).

Outside of controlled environments, language development in natural settings has also supported Chomsky's *UG* theory. Bickerton (1984) observed that pidgins and creoles highlight syntax as an innate entity (6). Pidgins are characterized as a grammatically simplified means of communication that emerges when speakers who do not share the same language need to communicate for functional needs. Creoles are therefore more developed versions of pidgins, characterized by more stable and complex grammatical structures. In his paper on the *Language bioprogram hypothesis*, Bickerton noted his findings: children exposed to highly unstructured pidgins such as that of the Hawaiian and Haitian formulated their own creoles with highly structured grammar, structure, and rules. This suggested that in the absence of syntactic exposure, persons were able to develop their own syntactic structures. Moreover, not surprising to the *UG* theory, the syntactic structures of these creoles had many similarities, often a preference for the subject-verb-object (SVO) word order.

1.1.2 *Neurophysiological evidence*

Taking a different approach, perhaps it is worth considering syntax as a non-linguistic structure, which would be another way of thinking about syntax as an innate mechanism. Greenfield (1991) and Lieberman's (1991) research highlighted that brain structures associated with linguistic functions such as syntax are actually originally associated with sensorimotor functions. Greenfield (1991) showed that the Broca's area commonly associated with functions for language production is used not only for linguistic functions but also for motor tasks when children are below the age of two. Distinct circuits for distinct functions — linguistic and sensorimotor — develop later on in life, but this finding on the fundamental function of the Broca's area may suggest that syntax is non-linguistic to begin with (7). There are inbuilt physiological structures which play definitive roles in the use of syntax.

Taking another approach, being intrinsic to human capacity could be taken to mean, spontaneous. Pulvermüller et al. (2008) investigated whether syntactic processing required attention or is automatic (8). Participants were asked to distinguish between grammatical and ungrammatical speech, while they underwent a series of interference tasks. The first interference task was a *"passive cross-modal distraction*" of watching a silent video film. However, because Pulvermüller et al. recognized the limitations of cross-modality interference as a way of justifying the automaticity conclusion (9), they also facilitated a second interference task that involved an "*active distraction task*" of performing an acoustic signal detection task in which they heard speech stimuli in their right ear and distraction stimuli in their left ear, such that both the stimuli and interference were of the same modality. Using syntactic Mismatch Negativity (MMN) (10), which is a component of Event-Related Potential (ERP) that reflects the brain's automatic detection of any perceptible change in some repetitive aspect of an auditory stimulation, they found that the identification of grammaticality is a reflex when it happens within 150 ms after the exposure to stimulus.

**1.2** *Syntax is acquired*

Despite the behavioral and neurophysiological evidence that has been put forth for the innate syntax theory, other scholars are not convinced. Critics argue that the empirical foundation of the *UG* theory is less robust than often claimed. For example linguist Geoffrey K. Pullum comments, "the properties of UG tend to be more boasted of than empirically validated (11)." For one, human languages do not agree upon a specific syntactic rule: "Human languages turn out to be so diverse in grammatical terms that a tight set of true universal principles governing them all can hardly be imagined. Some have word formation and inflection processes of extreme complexity: whole sentences can often be expressed as single words in Eskimoan languages. Others (like Vietnamese) have virtually no word-building. Some (like English) maintain fairly strict constituent order, while others (like Sanskrit, and many aboriginal languages of Australia) have remarkably free word order. Languages differ, for instance, in the order of Subject (S), Verb (V), and Object (O), in every way they logically could. There are only seven logical possibilities for the normal order for simple, stylistically neutral, declarative clauses, we find all seven favored in at least some languages: SVO (English, Swahili); SOV (Turkish, Japanese); VSO (Hawaiian, Irish); VOS (Malagasy, Tzotzil); OVS (Hixkaryana, Urarina); OSV (Apurinã, Nadëb), and no strong preference (Sanskrit, Walbiri)" (11).

The syntactic variety in natural human languages refutes Chomsky's *UG* theory. Perhaps it is worth considering that though the innate syntax argument may be true, that only seems to be true when a person lacks exposure to any syntactic form and thus is forced to make their own as the last resort. The innate syntax argument does not apply to any actual language with already fixed syntactic structures and rules.

Additionally, Pullum and Scholz (2002) refute children's need for an innate syntactic mechanism to compensate for their insufficient exposure to syntactic variations. They contend that even this limited set of syntactic variations children are exposed to should not be underestimated in fostering their acquisition of syntax (12). Based on the assumption that "*a construction inaccessible to infants during the language acquisition process must be rare enough that it will be almost entirely absent from corpora of text quite generally*", Pullum and Scholz (2002) analyzed a number of linguistic features including "*Plurals in noun-noun compounding*" and the "*Anaphoric* one", and the respective frequencies at which they appear in the corpora. The former refers to the grammaticality of "irregular plurals as first elements of compounds to form novel items like *teeth-eater*" in contrast to the ungrammaticality of "regular plurals in a similar way to form *toys-eater*." The latter has already been explained using Lidz et al.'s (2003) study (5). Pullum and Scholz (2002) found that though these linguistic features appeared in the corpora with varying degrees of frequency, they were nevertheless present. They critique therefore that proponents of the *UG* theory must reach a consensus on the specific frequency at which a linguistic feature must be present in the child's linguistic data for it to be considered as a linguistic feature to which children are sufficiently exposed. The current challenge with the innate syntax theory is that there is no such consensus, making the theory not capable of being falsified.

The existing experimental studies that could pragmatically discredit the innate syntax theory follow.

1.2.1 *Behavioral evidence*

Syntax could be considered as an acquired mechanism if people adopt only the syntax that they receive the most exposure to. Kumarage (2024) found that children have a tendency to adopt the syntax they have more exposure to (13). Using syntactic priming, which is the tendency to persist in the use of a structure after previously hearing or using it, Kumarage (2024) found that higher exposure to passive compared to active syntactic sentences produced more passive sentences at an initially increasing rate, which later decreased once the target structure had been acquired. The preceding was inferred from a longitudinal study performed from when the children were 36 months old to when they were 54 months old. People's syntactic preferences shift accordingly with syntactic structures they are most frequently introduced to, suggesting that syntax is obtained from the external environment rather than being innately rooted.

1.2.2 *Neurophysiological evidence*

Like Pullum and Scholz (2002), Elman and Lewis (2001) repudiate the *Poverty of the Stimulus*. They point out that the linguistic input of children contains relevant features in sufficient abundance to support syntactic acquisition in the absence of innate mechanisms (14). Using a neural network model termed the Simple Recurrent Network (SRN) developed by Elman in 1990, Elman and Lewis (2001) demonstrated children's learnability of aux-questions, questions that use auxiliary verbs, even with limited exposure to such syntactic structures — a finding that contradicts prior experimental evidence by Crain and Nakayama (1987). They found that through training, the SRN was capable of predicting relative clauses in subject position in aux-questions from data which contained no such questions. An example would be predicting aux-questions such as, "is the boy who is smoking crazy?" instead of "is the boy who smoking is crazy?". The SRN was only provided with "a corpus of language-like sentences either simple (transitive or intransitive), or contained multiple embedded relative clauses (in which the head noun could be either the subject or object of the subordinate clause)".

However, Elman and Lewis' (2001) findings have been called into question for reliability since they only evaluated the capability of one neural network in remodeling a question. Their research has therefore been strengthened by Frank and Matthis (2007) as well as McCoy et al. (2018) who evaluated the capability of another neural network termed the Recurrent Neural Network (RNN) to model a question from a declarative sentence (15). McCoy et al. (2018) in particular found that one of the RNN managed to consistently learn a hierarchical generation for question formation, despite its preference for linear structures over hierarchical ones. Accordingly, they concluded: "This suggests that a learner's preference for hierarchy may arise from the hierarchical properties of the input, coupled with biases implicit in the network's computational architecture and learning procedure, without the need for pre-existing hierarchical constraints in the learner" (15).

## 2. Materials and Methods

Previous research indicates the multifaceted nature of the nature-versus-nurture discussion on syntax acquisition. Proponents of the innate syntax argument argue the finitude of linguistic exposure, and the necessity of an innate syntactic mechanism that has an inherent preference for a specific syntactic structure, if they were not taught so explicitly. However, defenders of the acquired syntax undermine this argument. They argue that such a statement has by far not been empirically validated. They also argue that such a statement fails to be applied in the context of the real world where people have successfully adopted a variety of syntactic structures, if they were taught explicitly.

This study's objective is to provide additional insights into the ongoing discussion surrounding syntax acquisition. The definition of syntax was framed around Chomsky's *UG* theory, which states that syntax is independent of semantics, solely dependent on the identification and internalization of regularities in word order.

This framework of syntax holds true in experiments involving the probing of syntactic knowledge using artificial grammar, which refers to any form of rules-based structures that are not restricted to the domain of natural languages. For example, Lelekov-Boissard and Dominey (2002) found that linguistic syntactic structure and non-linguistic abstract structure (i.e., artificial grammar) are similar at the neurological level (16). When participants processed the non-linguistic abstract structure — sequences of colored geometric figures — the brain exhibited a late positivity of approximately 500 milliseconds, measured using the ERP which are neurophysiological signals that allow for the analysis of the timing of various cognitive processes (17). This brain response is typically observed with linguistic syntactic processing. The study's findings suggest that similar brain mechanisms are involved in processing any form of rules governing structures. The cognition is predisposed to handle syntax in natural languages similar to how it handles other rules-based structures, which are, in turn, independent of features associated with natural languages such as propositions, methodology, tense, and mood. Likewise, Westphal-Fitch et al.'s (2018) study demonstrates that humans can acquire and generalize abstract rule systems in the visual domain not specific to any language without relying on meaning, using artificial grammars that include hierarchical structure (18). Operationalizing syntax through word order patterns is thus consistent with existing studies on syntactic learning. For this reason, this study focused on testing participants' sensitivity to word order.

Nevertheless, there are competing theoretical frameworks of syntax. A commonly accepted theory for syntax is Pinker's (1984) semantic theory (19). This theory contradicts Chomsky's *UG* theory, postulating that the understanding of semantics is what underlies people's understanding of syntax. Pinker's theory explains that people's instinctive distinction between the entities of an object, place, time, event, proposition, etc. is what allows them to efficiently adopt the syntactic structure of the target language they are exposed to: "According to the bootstrapping proposal, the child not only has innate syntactic categories, but also has innate semantic flags for them. Thus, there is an innate default assignment of words for objects to the noun class, of actions and changes of state to the verb class, of agents to subject, etc. These assignments enable the child to recognize instances of the syntactic categories in the input before having acquired any syntactic rules of the target language" (19).

Such an alternative framework of syntax is evident in neurophysiological findings. Neurological evidence from lesion studies on syntax in patients with agrammatic Broca's aphasia suggests that syntax is a combination of the left cerebral hemisphere (word order) and Broca's area (semantics under word order). Grodzinsky (2000) shares that the "combinatorial aspects of the language faculty reside in the human left cerebral hemisphere, but only the transformational component (or algorithms that implement it in use) is located in and around Broca's area" (20). There are specific brain regions and activity associated with distinct functions — word order recognition and semantics — involved in syntactic processing. Using synthetic brain imaging techniques, Cangelosi and Parisi (2004) state: "In the computational model, nouns produce more neural activity in the sensory processing layer, while verbs produce more synaptic activity in the layer where sensory information is integrated with proprioceptive input to plan the action. In the human brain, nouns activate more the (posterior) areas of the brain related to sensory and associative processing, while verbs activate more the (anterior) motor areas" (21, 22).

Consequently, it is arguable that syntactic learning not only involves pattern recognition, but also meaning making. In spite of these limitations, this study chose to implement Chomsky's *UG* theory, in light of his resolute stance on syntax as an innate mechanism, which was viewed as directly relevant to the objectives of this study. While syntax does involve more than just word order, isolating word order controls for semantic confounds and allows for clearer hypothesis testing.

Specifically, this study compared the learning abilities of Japanese and English speakers in acquiring the syntactic structures of Turkish and Mandarin. According to Dryer's classification of syntactic categories based on the order of subject, verb, and object (23), Japanese and Turkish share a similar syntactic structure with a subject-object-verb (SOV) word order, whereas English and Mandarin follow a subject-verb-object (SVO) order. In line with the acquired syntax theory, this study predicted that there would be differences in how Japanese and English speakers acquire the syntax of Turkish and Mandarin. Conversely, in line with the innate syntax theory, this study predicted that the learning of these languages would be similar across all speakers, regardless of the syntactic structures of their native language.

Unlike most studies on syntax acquisition that primarily focus on children, this study also included adults. The objective was to uncover patterns and tendencies in language acquisition across all age groups, providing an age agnostic view of how nativism versus empiricism shapes syntax acquisition throughout life. In addition, using natural languages such as Turkish and Mandarin enhanced the ecological validity of the findings. While most studies grounded in Chomsky's theoretical framework of syntax have employed artificial grammars, the use of natural languages offered insights into syntax acquisition tendencies of typical speakers who had been taught explicit syntactic rules in their native language (Japanese and/or English).

**2.1** *Hypotheses*

Hypothesis 1 posited that syntax is innate. Therefore, both Japanese (SOV) and English (SVO) speakers will perform similarly in learning Turkish (SOV) and Mandarin (SVO). Hypothesis 2 posited that syntax is acquired. Therefore, Japanese (SOV) speakers will perform better than English (SVO) speakers in learning Turkish (SOV). Accordingly, English (SVO) speakers will perform better than Japanese (SOV) speakers in learning Mandarin (SVO). Furthermore, there should be an observable improvement in syntactic knowledge with increased exposure to the target language's syntactic structure.

**2.2** *Participants*

To test these hypotheses, an online questionnaire was distributed to a target population consisting of Japanese and English speakers. The distribution period spanned from November 24, 2024 to December 20, 2024. The primary outlets for distributing the questionnaire were the experimenter's personal contacts, and participants voluntarily opted to take part. This sampling method combined both opportunity and volunteer sampling.

The study included a total of 111 participants, all of whom were either Japanese or English speakers. Among them, 55 were familiar with both Japanese and English, 10 with only Japanese, and 46 with only English (Figure 1). 1 participant was native in both languages, 53 in only Japanese, 38 in only English, and 19 in other languages (Figure 2). Overall, participants reported being proficient in a total of 45 languages. Based on Dryer's classification of syntactic categories (24), 1 participant was native in both SOV and SVO word orders, 58 in only SOV, 51 in only SVO, and 1 in a language with no dominant order (Figure 3). Figure 4 lists all languages spoken by participants (excluding those spoken by fewer than four), along with their corresponding syntactic categories.

| Familiarity with Japanese | Familiarity with English | | |
|---|---|---|---|
| | | Yes | No |
| | Yes | 55 | 10 |
| | No | 46 | 0 |

**Figure 1.** Table showing participants' familiarity with English and/or Japanese.

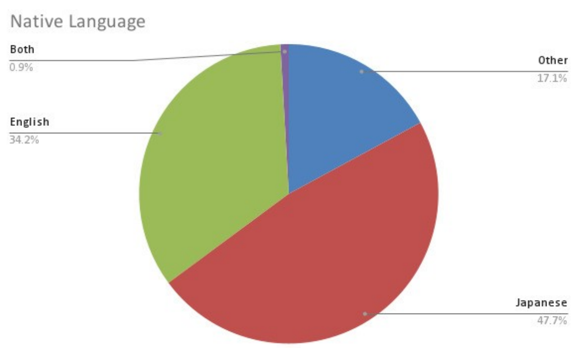


**Figure 2.** Pie chart showing participants' native language.

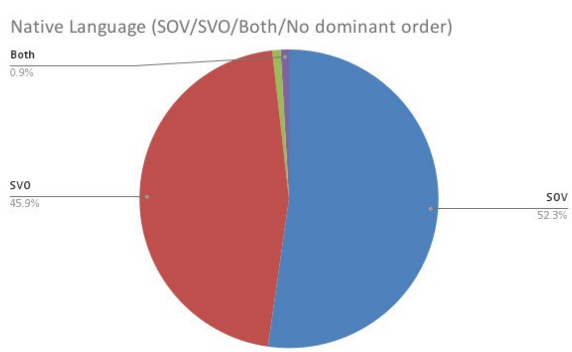


**Figure 3.** Pie chart showing participants' native languages based on syntactic category (SOV/SVO/Both/No dominant order).

| Language | Syntactic Category | Number of speakers |
|---|---|---|
| English | SVO | 101 |
| Japanese | SOV | 65 |
| Mandarin | SVO | 43 |
| French | SVO | 18 |
| Korean | SOV | 16 |
| Spanish | SVO | 13 |
| German | No dominant order | 11 |
| Italian | SVO | 10 |
| Malay | SOV | 6 |
| Tamil | SOV | 4 |

**Figure 4.** List of all languages spoken by participants (excluding those spoken by fewer than four) along with their corresponding syntactic categories.

Among the languages participants were familiar with, Mandarin and Turkish were of particular interest. The study focused on these languages, as participants were already familiar with languages of similar syntactic structures. This prior familiarity provided a foundation for assessing participants' learning ability of these languages. Participants were grouped based on their familiarity with these languages, and their learning ability was assessed as the dependent variable.

67 participants were familiar with neither Turkish nor Mandarin. These participants were used as the experimental group. The control group consisted of 1 participant who was completely familiar with Turkish but not Mandarin, 41 participants who were familiar with Mandarin but not Turkish; of these, 22 were fully familiar with Mandarin, while 19 were somewhat familiar. Only 2 participants were familiar with both languages, but both were only somewhat familiar with Turkish and fully familiar with Mandarin.

Participants' ages ranged from 11 to 79 years, with the following distribution: 47 were under 25, 12 were aged 25–34, 12 were aged 35–44, 22 were aged 45–54, 12 were aged 55–64, and 6 were 65 or older. These categories align with UNESCO's age definitions (24). The gender ratio was 36 male, 73 female, 1 non-binary/third gender, and 1 participant choosing not to disclose their gender. Participants' countries of current residence included 46 in Japan, 32 in Singapore, and 33 in other countries.

Participants were required to answer all questions on the questionnaire. 181 out of the initial 292 participants were excluded from the final sample due to incomplete responses, leaving 111 eligible participants.

**2.3** *Statement of informed consent*

Participants gave informed consent. They were informed that the study aimed at "understanding how individuals process and interpret sentences in different languages."

This description was sufficient to ensure informed consent while withholding the study's specific focus on syntax learning to minimize demand characteristics in participants' responses. Participants were fully informed of the study's duration, the confidentiality of their responses, the voluntary nature of their participation, and their right to withdraw on or before December 20, 2024. A point of contact was also given so that any questions that any participant had regarding the study could be answered.

**2.4** *Assessment materials*

This study was designed to assess participants' acquisition of the syntactic structures of Turkish (SOV) and Mandarin (SVO). The materials were presented in two phases: the exposure phase (Phase 1) and the testing phase (Phase 2). Both phases involved written sentences in either Turkish or Mandarin, prompting participants to focus on sentence structure rather than meaning.

2.4.1 *Phase 1: Exposure phase*

In the first phase, participants were presented with four sentences from either Turkish (SOV) or Mandarin (SVO). The sentences in both languages were structured according to their respective syntactic categories. The participants were then asked to rate their comfort level with reading these sentences. The instructions emphasized that the task was timed, and participants were encouraged to complete it as quickly as possible.

**Sample Sentence (Turkish (SOV)):**

1) ***O, onu seviyor.***
   *O* | *He/She/It* | 彼
   *onu* | *him/her/it* | 彼/彼女/それ
   *seviyor*| *loves* | 愛している

**Sample Sentence (Mandarin (SVO)):**

1) **她读书。**
   她 | *She* | 彼女
   读 | *to read* | 読む
   书 | *book(s)* | 本

Participants were asked to rate how comfortable they felt reading the sentences on a scale from "Very comfortable　とても読みやすかった," "Comfortable　読みやすかった," "Neutral　ふつう," "Uncomfortable　読みづらかった," to "Very uncomfortable　とても読みづらかった."

2.4.2 *Phase 2: Testing phase*

In the testing phase, participants were shown three novel sentences that followed the specific syntactic structures they were exposed to in Phase 1. Participants were asked whether the new sentences adhered to the same word order as the sentences they had read in the exposure phase, with response options: "Yes" or "No."

**Sample Sentence (Turkish (SOV)):**

1) ***Hediye'den Mary.***
   *Hediye* | *Gift* | プレゼント
   *den* | *from* | から
   *Mary* | *Mary* | メアリー

**Sample Sentence (Mandarin (SVO)):**

1) **我开车去公园。**
   我 | *I* | 私
   开车 | *drive* | 運転する
   去 | *go* | 行く
   公园 | *park* | 公園

After completing the exposure and testing phases, participants were asked which language — Turkish or Mandarin — they found easier to learn and why. This open-ended question provided further insights into their learning experience.

**2.5** *Assessment method*

The study utilized a repeated measures design, where all participants completed both the exposure and testing phases for both languages (Turkish and Mandarin). Each participant was expected to complete both phases in a single sitting. They were not able to continue editing their responses if they exceeded 24 hours from the start of the task.

The study was administered online using a questionnaire designed with Qualtrics. Qualtrics was an ideal software for this experimental design, as it enabled this study to not only track participant responses but also the duration taken to complete the tasks, offering valuable insights into syntactic learning processes.

**2.6** *Data analysis*

All statistical analyses were performed using R (Version 2024.09.1+394) to evaluate participant responses to the tasks, considering factors such as age, gender, location of current residence, language proficiency and syntactic category. P-values and other metrics were copied verbatim from software output, without regard to decimal places or significant figures as measures of precision.

**2.7** *Coding and scoring*

Given the nature of the data, coding and scoring were essential to convert qualitative responses into quantitative measures for analysis. The coding involved categorizing participants by age group, and letter identifier, based on UNESCO's classifications (under 25 (A), 25–34 (B), 35–44 (C), 45–54 (D), 55–64 (E), 65+ (F)) (24). The number of languages each participant reported knowing was also coded, assigning a score of 1 for each language. However, errors in this scoring are presented in the Discussion section.

The participants' syntactic categories were coded based on Dryer's classification (23). These categories were used to tally the number of languages spoken by each participant that followed SOV, SVO, or VSO/No dominant order.

Participants' responses in Phase 2 were also coded. The accuracy of their answers to the questions in the testing phase were coded as "Correct" and "Incorrect". Additionally, participants' explanations for why they found Turkish or Mandarin easier to learn were coded, if their input language was Japanese. This standardization of input language was done for more effective statistical analyses. Figure 5 shows the Japanese sentences that were coded into English, using Google Translate.

| **Original sentence (Japanese)** | **Coded sentence (English)** |
| --- | --- |
| 日本語に近い漢字が使用されていたため | Because kanji similar to Japanese were used |
| 言語学の知識を利用して答えようとしたが、それがむしろ考えを阻害してしまった。 | I tried to answer using my knowledge of linguistics, but it actually hindered my thinking. |
| 日本語と言葉の置き方が似ていたから | Because the way the words were placed was similar to Japanese |
| なんとなく | Somehow |
| トルコ語の方が文法がわかりやすい | Turkish grammar is easier to understand |
| 日本語に似ているから | Because it's similar to Japanese |
| 読めません | Can't read |
| 日本語の構成と似ているから | Because it has a similar structure to Japanese |
| ２例目だったから。中国語は構造が英語に似てたから。 | It was the second example. Chinese has a similar structure to English. |
| 知っている単語がいくつかあったから。加えて、トルコ語は文法を捉えづらかった。 | There were some words I knew. In addition, the grammar of Turkish was difficult to understand. |
| 明確さ | Clarity |
| 日本語と文章の作り方の順番が似ている | The order of writing sentences is similar to Japanese |
| 日本語も漢字があるのでなんとなく意味が想像できるのと、文法が複雑ではない気がするから | Japanese also has kanji, so I can kind of imagine the meaning, and I don't think the grammar is complicated. |
| 先に主語、述語が来て、その後修飾語がついていたから。 | The subject and predicate come first, followed by the modifier. |
| 日本語と似た並びがあったため | Because there was a similar arrangement to Japanese |
| 英語に似てるけど多分一番言いたいことが最後に来るのでは？と推測した。 | It's similar to English, but I guessed the thing you want to say most probably comes at the end. |
| 文の並びが日本語と似ているから | Because the sentence order is similar to Japanese |
| 文法がわかりやすかった | Grammar was easy to understand |

**Figure 5.** List of participants' Japanese responses explaining why they found Turkish or Mandarin easier to learn, along with their English translations using Google Translate.

## 3. Results

**3.1** *Mandarin was learned better than Turkish.* In Phase 1, participants in the experimental group excluding outliers determined by the Interquartile Range (IQR) method (Turkish: 128.234s, 138.602s, 1766.145s, 162.458s, 125.681 s, 118.813s, 225.712s; Mandarin: 67.113s, 93.433s, 61.807s, 61.411s, 91.722s, 80.654s) learned Mandarin significantly faster than Turkish (Figure 6). A paired t-test indicated that, on average, participants took 27.25 seconds less to learn Mandarin than Turkish (p-value = $2.449 \times 10^{-14}$). A similar trend was observed in the control groups, where participants also learned Mandarin faster than Turkish (Figure 7).

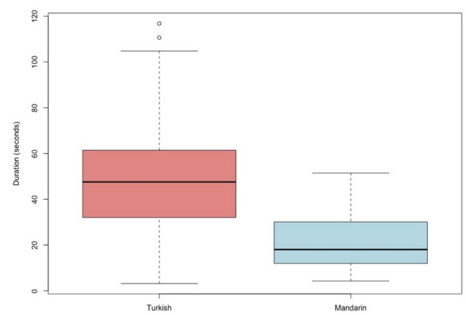


**Figure 6.** Box plot showing the learning duration (in seconds) for Turkish and Mandarin in Phase 1, for the experimental group, excluding outliers identified using the IQR method.

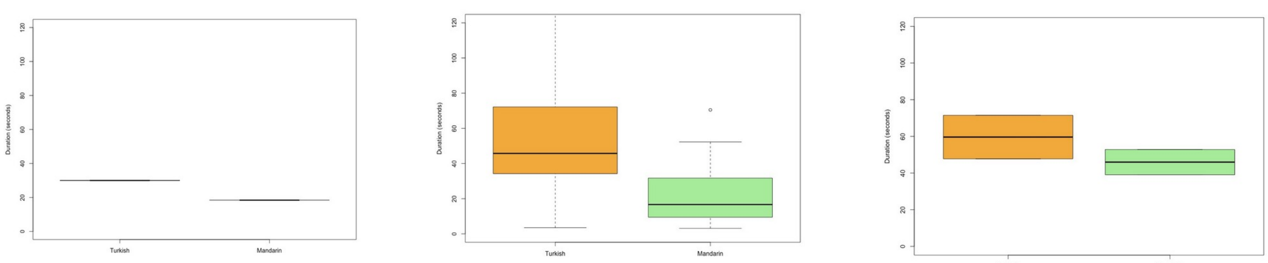

**Figure 7.** Box plot showing learning duration (in seconds) for Turkish and Mandarin in Phase 1, for the control groups.

Although a paired t-test could not be performed on the “Turkish” control group (i.e., familiar or somewhat familiar with Turkish but not Mandarin) due to the small number of participants in this group, this trend was observed by performing paired t-tests on other control groups. Specifically, the “Mandarin” control group (i.e., familiar or somewhat familiar with Mandarin but not Turkish) took 33.28 seconds less to learn Mandarin than Turkish (p-value = $1.691 \times 10^{-7}$). However, in the “Both” control group (i.e., familiar or somewhat familiar with both Mandarin and Turkish), participants took 13.67 seconds less to learn Mandarin than Turkish, though this difference was not statistically significant (p-value = 0.2231). Additionally, participants in the experimental group had a lower click count (i.e., the number of times they clicked on the screen) when learning Mandarin compared to Turkish. A paired t-test found that, on average, participants clicked 0.34 fewer times when learning Mandarin (p-value = 0.01363).

Figure 8 shows the distribution of comfort levels learning each language by participants in the experimental group. A Kruskal-Wallis test on their self-reported comfort levels showed no significant difference in how comfortable they felt with Turkish versus Mandarin (p-value = 0.536). The control groups had a similar distribution (Figure 9). In particular, the *Turkish* control group rated both languages as equally comfortable.

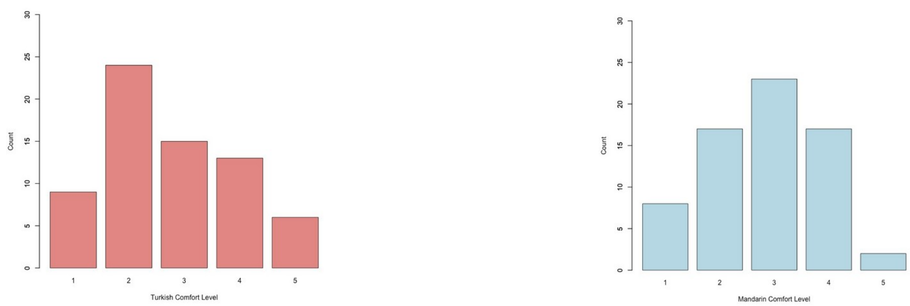


**Figure 8.** Bar graph showing the distribution of Turkish and Mandarin comfort levels in Phase 1, for the experimental group.

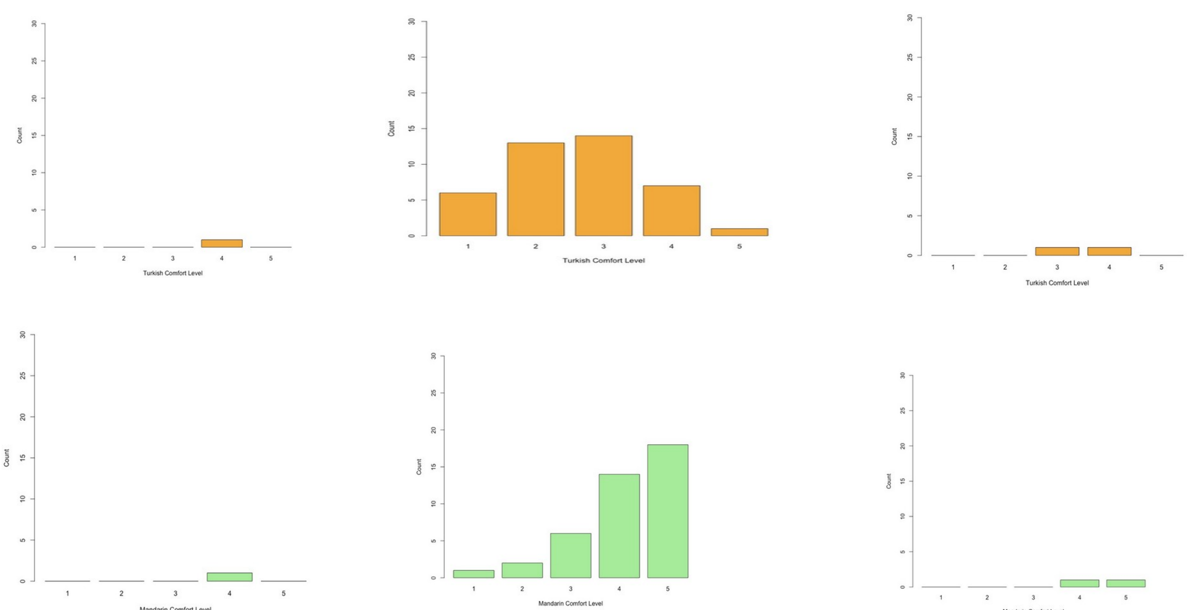


**Figure 9.** Bar graph showing the distribution of Turkish and Mandarin comfort levels in Phase 1, for the control groups.

In Phase 2, a paired t-test revealed that participants were, on average, 12.9 percentage points more accurate in Mandarin (p-value = 0.005806) (Figure 10).

The control groups were more accurate in the language they were familiar with — Turkish or Mandarin (Figure 11). The *Turkish* control group was more accurate in Turkish than in Mandarin, with a difference of 66.67%. The *Mandarin* control group achieved a higher accuracy in Mandarin than in Turkish by 21.14% (p-value = 0.0002775). In the *Both* control group, there was no statistically significant difference between Mandarin and Turkish based on a paired t-test (p-value = 0.5).

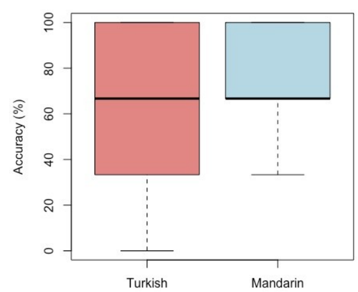


**Figure 10.** Box plot showing accuracy (%) against Turkish and Mandarin in Phase 2, for the experimental group.

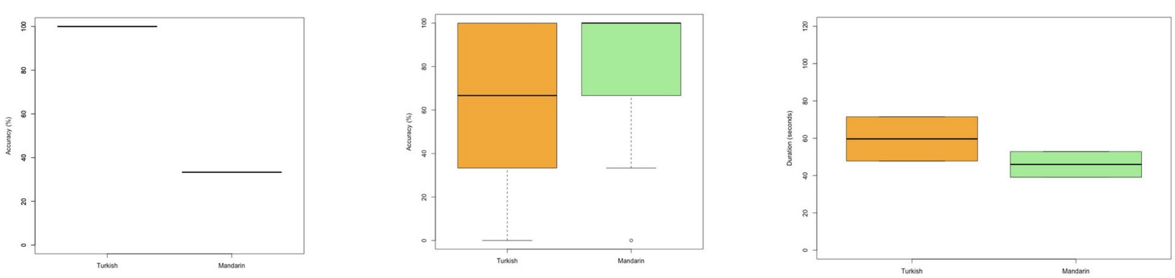

**Figure 11.** Box plot showing accuracy (%) against Turkish and Mandarin in Phase 2, for the control groups.

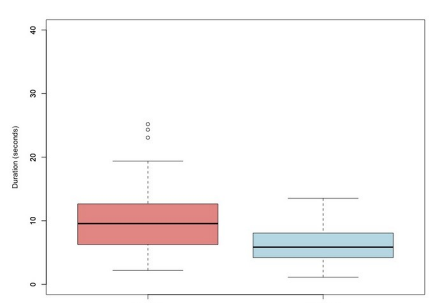

**Figure 12**. Box plot showing mean duration (in seconds) against Turkish and Mandarin in Phase 2, for the experimental group, excluding outliers identified using the IQR method.

A t-test showed that, on average, participants in the experimental group excluding outliers determined by the IQR method (Turkish: 40.847s, 32.246s, 28.181s, 39.576s; Mandarin: 26.195s, 21.339s) spent 4.16 seconds longer on Turkish (p-value = $1.323 \times 10^{-10}$) (Figure 12). The control group took less time completing Phase 2 for the language they were familiar with (Figure 13). A paired t-test on the *Mandarin* control group revealed they completed Phase 2 5.75 seconds faster for Mandarin than for Turkish (p-value = $4.952 \times 10^{-5}$). In the *Both* control group, the difference was not statistically significant (p-value = 0.3153).

Participants' click count in Phase 2 showed no significant difference between the two languages (p-value = 0.1125).

In terms of self-reported ease of completing Phase 2, more participants in the experimental group found Mandarin easier. As shown in Figure 14, over half (52.24%) of the group found Mandarin easier, while only 16 participants found Turkish easier. A $\chi^2$ goodness-of-fit test found this difference to be statistically significant (p-value = $1.293 \times 10^{-6}$). This trend was mirrored in the control groups (Figure 15), with all participants in the *Both* control group rating Mandarin as easier despite their familiarity with both Turkish and Mandarin.

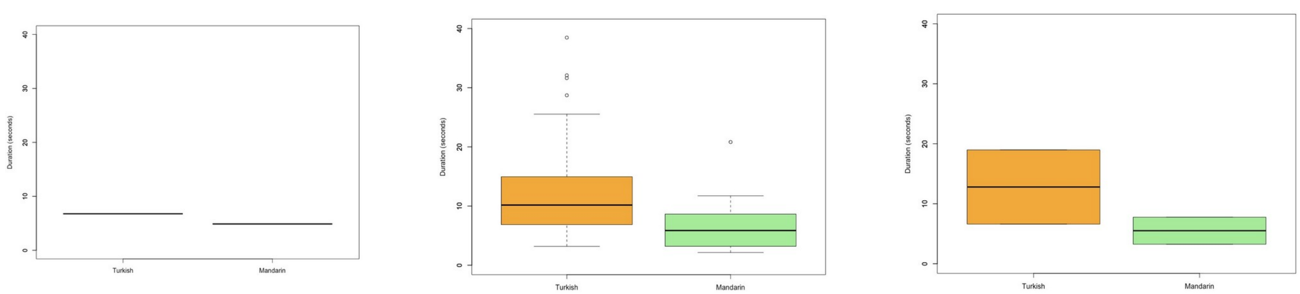


**Figure 13.** Box plot showing mean duration (in seconds) against Turkish and Mandarin in Phase 2, for the control groups.

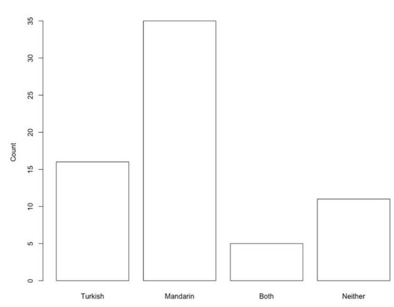


**Figure 14.** Bar graph showing the number of participants against the languages of reported ease, for the experimental group.

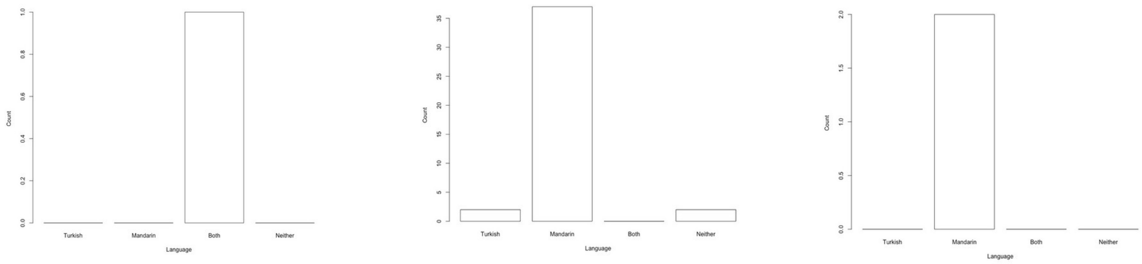


**Figure 15.** Bar graph showing the number of participants against the languages of reported ease, for the control groups.

In summary, all participants — regardless of whether they were in the experimental group or control group — learned and performed better in Mandarin acquisition than in Turkish. Participants also eventually recognized this manner of difference in their learning capabilities.

**3.2** *Turkish was learned better by Japanese (SOV) speakers, while Mandarin was learned better by English (SVO) speakers.*

Although Mandarin was learned better than Turkish by most, if not all, participants, there were varying levels of learning capability within different subgroups of the experimental group. To illustrate the differences in performance between the different subgroups discussed in this section, a baseline comparison was created for reference. (Figure 16).

| Language | Mean Accuracy (%) | Median Accuracy (%) | Mode Accuracy (%) |
|---|---|---|---|
| Turkish | 63.68 | 66.67 | 66.67 |
| Mandarin | 76.62 | 66.67 | 66.67 |

**Figure 16.** Table showing the mean, median, and mode of Turkish and Mandarin accuracy (%) for all participants in the experimental group.

In Phase 2, participants familiar with only Japanese had, on average, the highest accuracy in identifying correct and incorrect sentences in Turkish among the subgroups (Figure 17). The mean Turkish accuracy for those familiar with only Japanese was 76.67%, compared to 66.67% for those familiar with only English and 58.56% for those familiar with both Japanese and English. However, the differences in accuracy across the subgroups with varying languages of familiarity were not statistically significant (p-value = 0.2182), as determined by a Kruskal-Wallis rank sum test.

However, there was little variance in accuracy between the subgroups when identifying correct and incorrect sentences in Phase 2 for Mandarin. The mean Mandarin accuracy for those familiar with only Japanese was 76.67%, for those familiar with only English it was 73.33%, and for those familiar with both Japanese and English it was 78.38%.

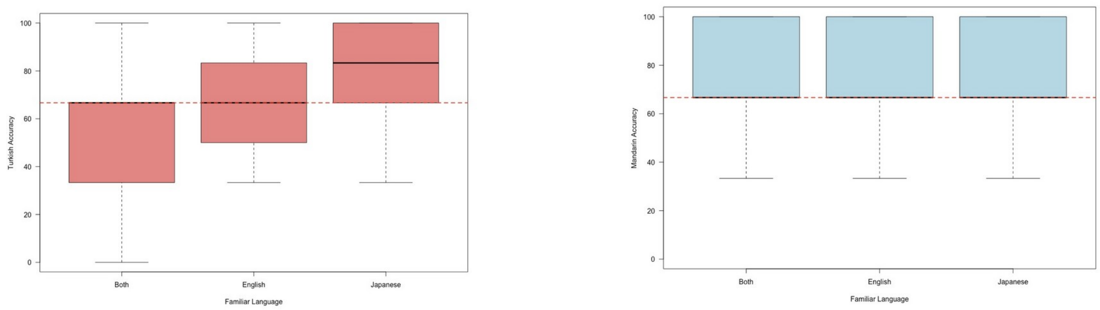


**Figure 17.** Box plot showing Turkish and Mandarin accuracy against familiar language, for the experimental group. The red dotted line indicates the median Turkish and Mandarin accuracy for all participants in the experimental group.

Additionally, participants with proficiency in fewer languages within the SVO syntactic category and more languages within the SOV syntactic category demonstrated better proficiency in learning Turkish (Figures 18 and 19). Specifically, participants who reported proficiency in none of the languages within the SVO syntactic category had the highest median Turkish accuracy of 83.33%, while those proficient in one or more SVO languages had a lower median Turkish accuracy of 66.67%. Moreover, participants who reported proficiency in the most languages (three) within the SOV syntactic category achieved the highest mean Turkish accuracy of 66.67%. This was followed by participants proficient in two SOV languages, with a mean Turkish accuracy of 63.64%, and those proficient in one SOV language, with a mean Turkish accuracy of 62.70%. Yet, participants who reported no proficiency in any language within the SOV syntactic category performed contrary to this trend, showing a mean Turkish accuracy of 66.67%.

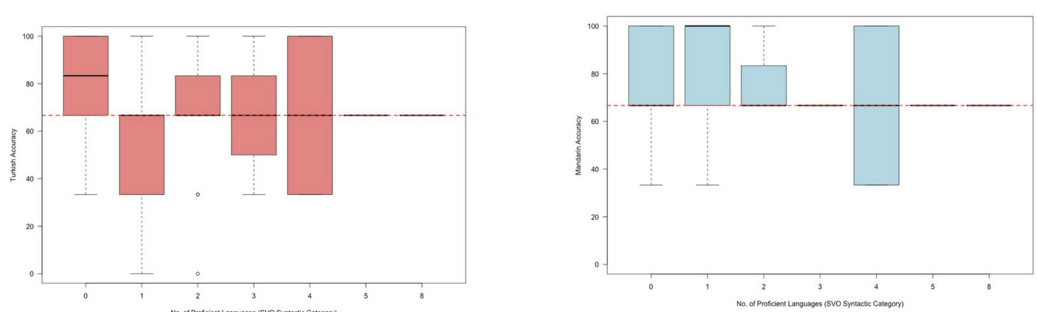


**Figure 18.** Box plot showing Turkish and Mandarin accuracy against the number of proficient languages within the SVO syntactic category, for the experimental group. The red dotted line represents the median Turkish accuracy for all participants in the experimental group.

However, a similar logic did not materialize for participants' acquisition of Mandarin. The highest mean and median Mandarin accuracy scores of 80.21% and 100%, respectively, were achieved by participants who reported proficiency in only one language within the SVO category (Figure 18). This was followed by scores of 76.67% for participants proficient in no SVO languages, 75.00% for those proficient in two SVO languages, and 66.67% for those proficient in three or more languages within the SVO category. Additionally, there was no difference in the median Mandarin accuracy scores across participants, regardless of the number of languages they spoke within the SOV category, with all groups achieving a median of 66.67% (Figure 19).

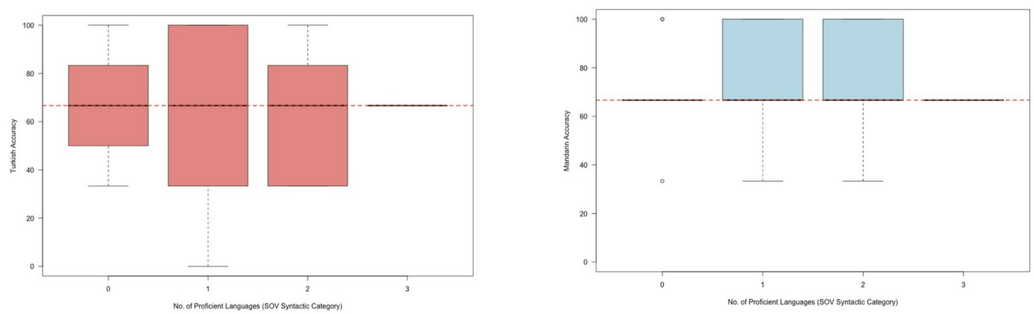


**Figure 19.** Box plot showing Turkish and Mandarin accuracy against the number of proficient languages within the SOV syntactic category, for the experimental group. The red dotted line indicates the median Turkish accuracy for all participants in the experimental group.

**3.3** *With more exposure, participants learned the language better.*

There was a positive correlation between increased exposure and better language acquisition. Participants proficient in 11 to 12 languages achieved perfect accuracy (100.00%) in identifying correct and incorrect sentences (Figures 20 and 21), while those proficient in 5 to 6 languages achieved the second-highest accuracy, though patterns varied between Turkish (Figure 20) and Mandarin (Figure 21).

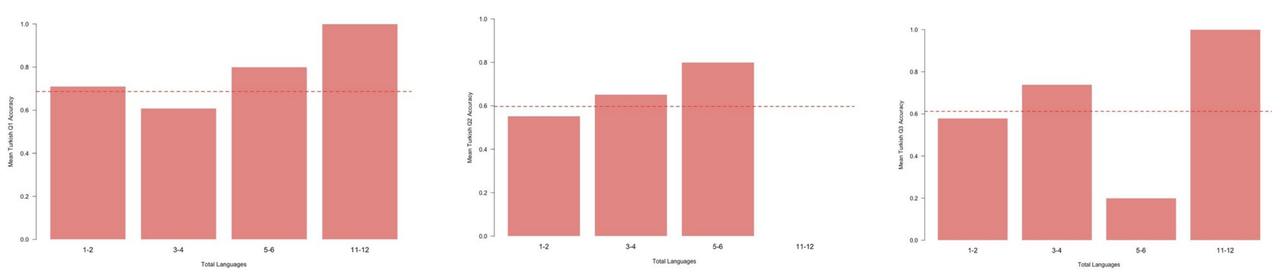


**Figure 20.** Bar graph showing the mean Turkish Q1/Q2/Q3 accuracy against total number of languages participants reported proficiency in, for the experimental group. The red dotted line indicates the mean Turkish Q1/Q2/Q3 accuracy for all participants in the experimental group.

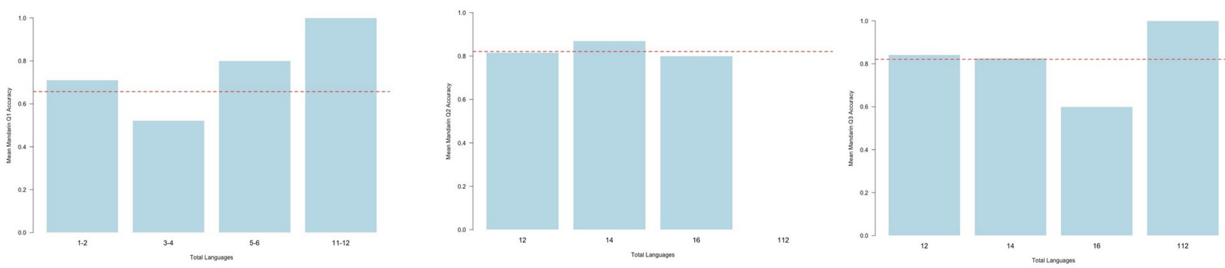


**Figure 21.** Bar graph showing the mean Mandarin Q1/Q2/Q3 accuracy against total number of languages participants reported proficiency in, for the experimental group. The red dotted line indicates the mean Mandarin Q1/Q2/Q3 accuracy for all participants in the experimental group.

For Question 1, participants proficient in 5 to 6 languages achieved the highest accuracy among those proficient in 6 or fewer languages, scoring 80.00%. For Question 2, participants proficient in 3 to 4 languages achieved the highest accuracy, with a score of 86.96%. For Question 3, the group proficient in 1 to 2 languages achieved the highest accuracy, with a score of 84.21%. In both Turkish and Mandarin, Age Group F demonstrated the highest accuracy in most questions (Figures 22 and 23). Age Group A also demonstrated a high accuracy, surpassing the overall accuracy threshold in most questions for Turkish (Figure 22). For Mandarin, Age Group A consistently ranked second, except in Question 3, where other age groups outperformed it (Figure 23).

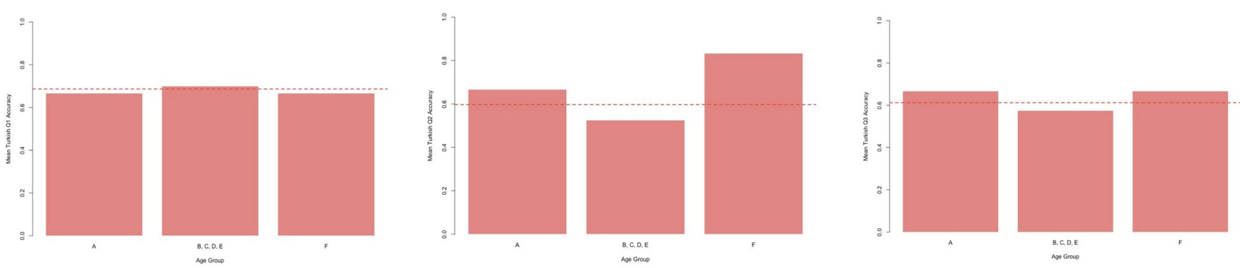


**Figure 22.** Bar graph showing the mean Turkish Q1/Q2/Q3 accuracy against age group, for the experimental group. The red dotted line indicates the mean Turkish Q1/Q2/Q3 accuracy for all participants in the experimental group.

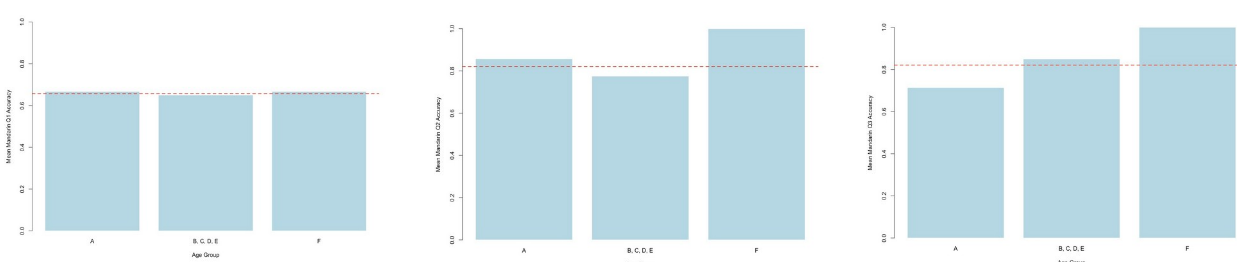


**Figure 23.** Bar graph showing the mean Mandarin Q1/Q2/Q3 accuracy against age group, for the experimental group. The red dotted line indicates the mean Mandarin Q1/Q2/Q3 accuracy for all participants in the experimental group.

Figures 24 and 25 present tables that illustrate the performance progression patterns for Turkish and Mandarin questions in Phase 2, respectively. With the exception of 28.36% of participants whose accuracy declined across the Turkish questions, the overall trend shows that most participants either maintained consistent accuracy or improved as they progressed. Only a small percentage of participants answered all questions incorrectly. The difference in percentages of participants who belonged to each performance progression pattern was statistically significant, as determined by a $\chi^2$ test with 95% confidence. For Turkish, the p-value for the difference was 0.003082, and for Mandarin, it was $5.125 \times 10^{-9}$.

| Participant Performance Progression Patterns across Turkish Questions in Phase 2 | | | | |
|---|---|---|---|---|
| Best (✓✓✓) | Better (✗✗✓/✗✓✓) | Neutral (✗✓✗/✓✗✓) | Worse (✓✗✗/✓✗✗) | Worst (✗✗✗) |
| 26.87% | 20.90% | 17.91% | 28.36% | 5.97% |

**Figure 24.** Table showing participant performance progression patterns across Turkish questions in Phase 2, for the experimental group.

| Participant Performance Progression Patterns across Mandarin Questions in Phase 2 | | | | |
|---|---|---|---|---|
| Best (✓✓✓) | Better (✗✗✓/✗✓✓) | Neutral (✗✓✗/✓✗✓) | Worse (✓✗✗/✓✗✗) | Worst (✗✗✗) |
| 38.81% | 28.36% | 20.90% | 11.94% | 0% |

**Figure 25.** Table showing participant performance progression patterns across Mandarin questions in Phase 2, for the experimental group.

**3.4** *Participants were aware of being tested on syntactic categories. This did not have an effect on their learning performance.*

The word cloud (Figure 26) shows the frequency of words used by participants to explain why they found either Turkish, Mandarin, both, or neither, easy to learn. Larger font words indicate higher frequency (f). Accordingly, the most frequently used words were “similar” (f:17), “order” (f:16), “structure” (f: 7), “grammar” (f:5), and the languages in discussion “english” (f:9) and “japanese” (f:8) most frequently.

Participants who found Turkish easier to learn, or who considered both Turkish and Mandarin equally easy, achieved Turkish accuracy scores above the mean accuracy of all participants in the experimental group (Figure 27). However, this was not always the case. As shown in Figure 28, only the group of participants who reported finding Turkish easier to learn achieved a Mandarin accuracy score above the mean accuracy of all participants in the experimental group.

Additionally, although participants native in English were expected to perform better in Mandarin due to its syntactic similarities with English, they also outperformed participants native in Japanese and Turkish (Figure 29).

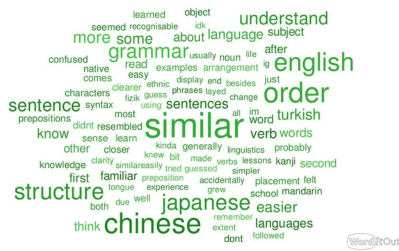


**Figure 26.** Word cloud showing the frequency of words used by participants to explain why they found either Turkish, Mandarin, both, or neither easy to learn.

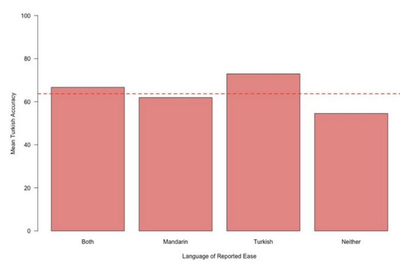


**Figure 27.** Bar graph showing the mean Turkish accuracy against the languages of reported ease, for the experimental group. The red dotted line indicates the mean Turkish accuracy for all participants in the experimental group.

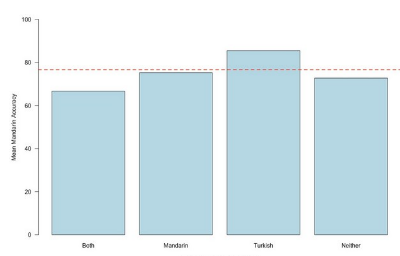


**Figure 28.** Bar graph showing the mean Mandarin accuracy against the languages of reported ease, for the experimental group. The red dotted line indicates the mean Mandarin accuracy for all participants in the experimental group.

| | Mean Accuracy | | |
|---|---|---|---|
| Language | Native in both English and Japanese | Native in English | Native in Japanese |
| Turkish | 100.00% | 66.67% | 60.47% |
| Mandarin | 100.00% | 79.48% | 77.52% |

**Figure 29.** Table showing the mean accuracy against native language, for the experimental group.

Likewise, although participants native in a SVO language were anticipated to perform better in Mandarin due to Mandarin's SVO syntactic structure, they also outperformed participants native in a SOV language in Turkish (Figure 30).

Finally, although it was expected that participants familiar only with English would perform better in Mandarin due to the syntactic similarities between English and Mandarin, their performance was similar to that of participants familiar only with Japanese in Turkish (Figure 31). Additionally, participants familiar with both English and Japanese performed worse than those familiar with only one of these languages in Turkish.

| | Mean Accuracy | | |
|---|---|---|---|
| Language | Native in both SVO and SOV syntactic categories | Native in SVO syntactic category | Native in SOV syntactic category |
| Turkish | 100.00% | 66.67% | 61.81% |
| Mandarin | 100.00% | 74.51% | 77.08% |

**Figure 30.** Table showing the mean accuracy against the syntactic category of the native language, for the experimental group.

| | Mean Accuracy | | |
|---|---|---|---|
| Language | Familiar with both English and Japanese | Familiar with English | Familiar with Japanese |
| Turkish | 58.56% | 66.67% | 76.67% |
| Mandarin | 78.38% | 73.33% | 76.67% |

**Figure 31.** Table showing the mean accuracy against familiar language, for the experimental group.

**3.5** *Other inferences*

The results presented in this section are open to interpretation, thus identifying potential areas for further research.

Figures 32 and 33 show the Phase 2 accuracy of participants whose native language was neither Japanese nor English. While these results are inconclusive due to the small sample size, they offer preliminary insights into the potential influence of proficiency in languages other than Japanese and English on the acquisition of Turkish and Mandarin. Being native in Telugu (SOV) meant achieving perfect accuracy in both Turkish and Mandarin. Contrary to what would be expected by its syntactic category, being native in French (SVO) meant higher than average accuracy in Turkish, but lower than average accuracy in Mandarin. Additionally, being native in Russian (SVO) meant lower than average accuracy in Turkish; being native in Korean (SOV) meant higher than average accuracy in Mandarin; and being native in Tamil (SOV) meant lower than average accuracy in Mandarin.

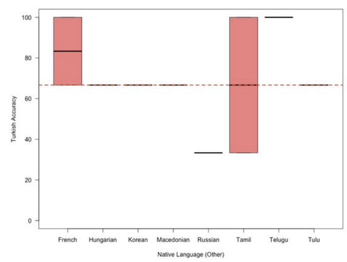


**Figure 32.** Box plot showing Turkish accuracy against native language (other), for the experimental group. The red dotted line indicates the mean Turkish accuracy for all participants in the experimental group.

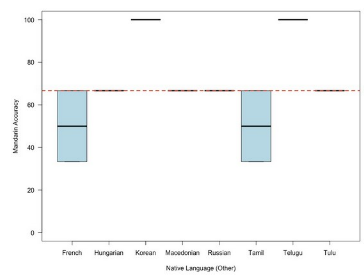


**Figure 33.** Box plot showing Mandarin accuracy against native language (other), for the experimental group. The red dotted line indicates the mean Mandarin accuracy for all participants in the experimental group.

## 4. Discussion

### 4.1 *Hypothesis 1*

As predicted in the first hypothesis, a subset of results suggested that syntax may be innate. All participants, including those in the experimental and control groups, performed similarly in learning both Turkish (SOV) and Mandarin (SVO). More specifically, all participants learned Mandarin better than Turkish (Figures 6 to 14). Participants demonstrated less hesitation and confusion while learning Mandarin than while learning Turkish in Phase 1 (Figures 6 and 7). What was particularly interesting was that this difference in their learning capacities between Turkish and Mandarin went unnoticed by participants, as the distribution of their comfort levels did not show a statistical difference between languages (Figure 8 and 9). In Phase 2, participants in the experimental group demonstrated significantly higher accuracy in distinguishing correct and incorrect sentences in Mandarin compared to Turkish (Figure 10). Additionally, these participants demonstrated significantly less hesitation making this distinction in Mandarin than in Turkish (Figure 12). At this stage, participants became aware that Mandarin was easier to learn than Turkish (Figure 14).

The innateness of syntax — particularly the SVO word order pertaining to Mandarin — presented a finding that could be supported by Bickerton's (1984) research which highlighted a preference for the SVO word order in creoles (6). Nonetheless, it challenged conclusions drawn by earlier studies on syntax acquisition.

For instance, Goldin-Meadow et al. (2010) observed that in the absence of formal language instruction children developed a syntax that was oriented around the patient: “When not exposed to a usable conventional language model, children display a patient bias in their self-generated communication systems” (2). The SOV word order could be considered a syntactic structure that aligns more closely with a patient-focused syntax, as the object (or patient) is positioned closer to the verb than that in the SVO structure. Based on this study’s results, however, participants preferred not the patient-focused, but rather the agent-focused SVO syntax. This finding was also particularly intriguing, especially in light of Greenberg’s (1963) findings that the vast majority of the world’ languages follow a SOV syntactic structure (25).

A potential explanation for this observation is that, though the majority of the world’s languages could follow a SOV syntax, the population size of speakers varies by language. In 2023, 6 out of the 10 most spoken languages worldwide followed the SVO syntactic structure. English and Mandarin were the leading languages, each having ~ double the number of speakers of the other languages in the top 10 (26). A more compelling explanation for people’s preference for the agent-focused SVO syntax, which would be an area for further research, draws on Slobin’s (1977) theory. Slobin proposed that the prevalence of non-SOV syntaxes, despite the innate predisposition for patient-focused SOV structures, could be attributed to “a number of pressures that language faces — pressures to be clear, processible, quick and easy, and expressive (2).” While SOV syntax prioritizes clarity, non-SOV structures such as SVO syntax may enhance speed and expressiveness, with a greater emphasis on the subject than the object. Such features of the SVO syntax may make the structure more appealing for use in contemporary society. Today, there is a growing emphasis on individualism and self-expression. Scholars Santos et al. (2017) have found a rise in individualism over the past 51 years, based on data from 78 countries (27). This shift toward valuing personal agency and expression may explain individuals’ growing preference for syntactic structures like SVO that highlight the agency of the subject. This could explain why languages such as English and Mandarin that follow this structure were learned with greater ease, in spite of contradicting evidence. Additionally, a plausible explanation for the participants’ preference for the SVO syntax may lie in a biased sample, with relatively few participants familiar with only Japanese compared to those familiar with either only English or both English and Japanese. This bias could account for why many participants found it easier to acquire Mandarin, since English, which shares a similar syntactic structure with Mandarin, was more commonly spoken (or was familiar) among the participants.

**4.2** *Hypothesis 2*

On the other hand, other evidence from the results supported the second hypothesis, which suggests that syntax may be acquired. In Phase 2, participants in the control group were more accurate and less hesitant in the language they were familiar with (Figures 11 and 12). This suggested that the speakers’ prior familiarity with a language that had a similar syntactic structure to the tested language helped in their acquisition of that syntactically similar language. Japanese (SOV) speakers learned

Turkish (SOV) better than English (SVO) speakers (Figure 17). This suggests that prior familiarity with a language that had a similar syntactic structure to Turkish helped in their acquisition of Turkish. To add, SOV speakers learned Turkish (SOV) better than SVO speakers (Figures 18 and 19). Likewise, this highlights that participants learned a language better if it possessed a similar syntactic structure to the language(s) they were already familiar with. However, it was interesting to find that this did not apply to the acquisition of Mandarin. There was minimal difference between English (SVO) and Japanese (SOV) speakers in their acquisition of Mandarin. Perhaps this suggests that prior linguistic background and familiarity do not significantly affect one's learning capacity for languages like Mandarin, which possess a SVO syntactic structure, which; in turn; has been previously discussed as the syntactic structure more 'inbred' to human language systems. SVO speakers did not necessarily learn Mandarin (SVO) better than SOV speakers, since the number of languages in the SVO or SOV languages participants reported proficiency in showed minimal correlation with their Mandarin acquisition. Although most of the evidence supporting these conclusions was not statistically significant, it was deemed meaningful when comparing the accuracy of these different groups in relation to the average accuracy achieved by all participants in the experimental group (Figure 16).

Our second hypothesis also proposed that an observable improvement in syntactic knowledge, due to increased exposure to the target language's syntactic structure, would further support the view of syntax as an acquired linguistic feature. Participants who were proficient in a greater number of languages showed better performance in both Turkish and Mandarin (Figures 20 and 21). This suggested that greater exposure to diverse linguistic structures prior to the study most likely expanded participants' syntactic repertoire, which in turn facilitated their acquisition of Turkish and Mandarin. Mandarin, in particular, showed an interesting trend. As participants progressed through the Mandarin questions, those proficient in fewer languages began to outcompete those with greater multilingual proficiency. By the end, accuracy evened out across groups with varying language proficiency. This suggested that syntax may be innate and that the SVO syntax may be easier to acquire.

Participants' age also influenced their accuracy across the questions. Older participants tended to perform better in both languages (Figures 22 and 23). Given their age, it could be inferred that they had accumulated more life experience and been exposed to a wider variety of syntactic structures over time, possibly enhancing their ability to learn new syntactic structures with greater ease. However, participants in the youngest age group were found to have performed relatively well, with their results in close competition with those of the older participants. This phenomenon can be explained by the Critical Period Hypothesis, which posits that language acquisition is most efficient when it occurs early in childhood (28).

Finally, the findings that participants performed better with increased exposure to questions further reinforced the idea that exposure plays a crucial role in syntax acquisition (Figures 24 and 25). In essence, these results lent support to the second hypothesis that syntax is acquired.

**4.3** *Evaluation*

Participants could have been subject to demand characteristics (selection bias) on account of their awareness of being tested on syntactic categories. However, considering that this awareness did not affect their learning performance, participants could be said to have not been subject to these biases.

Many participants recognized that they were being tested on syntactic categories, as evidenced by their frequent use of words such as "order", "structure", and "grammar" to explain why they found either Turkish, Mandarin, both, or neither easier to learn (Figure 26). Some participants even identified one of the underlying hypotheses of this study, which predicted that Japanese (SOV) speakers would perform better than English (SVO) speakers in learning Turkish, while English (SVO) speakers would perform better than Japanese (SOV) speakers in learning Mandarin.

Participants who found Turkish easier to learn often referenced its similarity to Japanese, with comments like "the **order** of writing [Turkish] sentences is similar to Japanese," "[Turkish] has a similar **structure** to Japanese," and "similar to Japanese **grammar structure**," among others. Similarly, those who found Mandarin easier to learn often noted its similarity to English, with comments like "the word **order** is similar to the English I know," "the sentence **structure** is generally similar to English in the subject verb object manner with the main difference in preposition placement and the second verb being after the object," and "the **grammar** was similar to English **grammar**."

Conversely, there were outliers, such as one participant who identified Mandarin as easier to learn because "it's similar to Japanese." This may be due to shared characteristics between Japanese and Mandarin, aside from syntactic categories. As other participants pointed out, "Japanese also has kanji, so I can kind of imagine the meaning" or "because kanji similar to Japanese were used [in Mandarin]". "Kanji" refers to "ideograms (or characters) adapted from Chinese characters (29). An example of a word written in "kanji" is "漢字". This suggested that familiarity with kanji could influence participants' perception of Mandarin, in addition to its syntactic structure.

Despite this awareness of the study's aims, participants' learning performance was unaffected (Figures 27 to 31). Some participants performed better in languages they found difficult, whereas some performed worse in languages they found easy.

**4.4** *Limitations*

First, there was imprecision in participants' reported language proficiency. For example, when participants reported proficiency in "Chinese," it was assumed to refer to "Mandarin," though it could have included other Chinese dialects.

Second, there were inconsistencies and discrepancies in language proficiency reporting. For example, one participant did not list Turkish as a language they were proficient in but later indicated some familiarity. For this portion of the data, the information was left as originally reported. These discrepancies underscore the importance of recognizing the subjective and arbitrary nature of self-reported proficiency, as participants may overestimate or underestimate their language abilities, or may have difficulty recalling all the languages they are proficient in.

Third, participants may have understood the experimental procedures differently based on their native language and languages which they reported proficiency in. Translation introduces its own limitations, as translated sentences may not always convey a semantically identical message to participants. As a result, participants' engagement with the study could have varied depending on their familiar language — English or Japanese. Moreover, for participants whose native language was neither English nor Japanese, the instructions may have been particularly difficult to comprehend, potentially hindering their ability to learn Turkish and Mandarin as effectively as they could have.

Another potential confounding variable was the order effect, as for all participants, Turkish was learned first, followed by Mandarin. This could explain why participants generally performed better in acquiring Mandarin, as they had the opportunity to familiarize themselves with the study's structure. To illustrate, one participant explicitly noted "[Mandarin being] the second example" as the reason for why they found Mandarin easier to learn compared to Turkish. To address this issue, a possible future improvement could be to implement a repeated measures design with randomized counterbalancing. However, Figure 14 indicates that a considerable number of participants in the experimental group still found Turkish easier to learn compared to Mandarin, with a few others perceiving both languages as equally easy or difficult to learn. This suggested that the order effect may not have had a substantial impact on participants' performance in learning Turkish and/or Mandarin.

Another plausible confounding variable was the lack of standardization in the time participants took to complete the questionnaire. Although participants were encouraged to complete the task in one sitting, they were technically allowed up to 24 hours to submit their responses. This means that some participants may have completed the task intermittently, which could have undermined the accuracy of the metrics such as "click count" and "duration." This limitation was only realized after data collection had concluded, despite the availability of settings in Qualtrics that allowed for the response window to be shortened to 1 or 4 hours. This limitation was acknowledged during data analysis. To account for abnormal completion patterns and potential interruptions, outliers in response time were identified and excluded using the IQR method, as indicated in Figures 6 and 12. Nonetheless, future implementations of this study should enforce narrower completion windows and activity tracking features for stronger validity.

Furthermore, while this study chose to focus on Turkish and Mandarin as an SOV and SVO language, respectively, syntactic categories based on the order of subject, object, and verb vary across sources. For example, Mandarin is classified differently by various scholars: while Li and Thompson (1974) argue that Mandarin has evolved to adopt an SOV order, Sun and Givon (1985) maintain that Mandarin predominantly uses SVO order in 90% of constructions, with the other 10% of objects following other patterns (30). This variability underscores that syntactic structures of natural languages are not absolute. While the categorization used in this study follows Dryer's system (24), it is necessary to recognize that classifications differ from source to source.

As stated previously in the **2. Materials and Methods** section, it is also of contentious debate whether syntax can be defined purely as the order of words. In accordance with Pinker’s semantic theory (5) and other neurophysiological evidence, it may be argued that syntax is more than just the order of words, also a combination of semantics and meaning making. However, this study reiterated that this experiment framed the definition of syntax around Chomsky’s *UG* theory and other experiments on artificial grammar, in light of Chomsky’s resolute stance on syntax as an innate mechanism, which was viewed as directly relevant to the objectives of this study. After all, pattern recognition is a valid premise for assessing levels of syntactic learning. Participants’ performance on novel test sentences in the testing phase did reflect that only ~ quarter (26.87%) and < half (38.81%) correctly answered all questions for Turkish and Mandarin respectively (Figures 24 and 25). Many participants struggled to generalize the patterns productively to new utterances with new contexts. This suggests that syntax, even narrowly defined as pattern recognition, presents a genuine learning challenge. It taps into syntactic competition, not just rote pattern recognition. Nevertheless, the risk of over-interpretation of results cannot be discounted based on the unknown magnitude of the influence of rote pattern recognition.

Regardless, it is important to acknowledge that a possible improvement of this study may have been to use an artificial language to test syntax acquisition, since the definition of syntax was framed around Chomsky’s theory. Testing for syntax alone is difficult in natural language, as other language factors — such as lexis, tone, and discourse — may act as confounding variables. However, the goal of this study was to draw conclusions about syntax acquisition while maintaining strong ecological validity. In addition, this study saw the use of natural instead of artificial language as favorable, because it did not detract from alternative definitions of syntax. The use of natural language recognizes other frameworks of syntax not limited to just the order of words. It may be interesting in a future study to investigate a different definition of syntax, and see how results compare.

Nevertheless, the challenges of arriving at a definitive conclusion on syntax in natural language are difficult to undermine. Although this study specifically chose to compare syntactic acquisition between SVO and SOV word orders because they are among the most common, there are many other syntactic variations besides these two. For example, some participants reported proficiency in languages whose syntactic structures are different from these word orders, such as Tagalog, which follows a verb-subject-object order, and languages like German, Hungarian, Dutch, and Greek, which do not have a dominant word order.

Additionally, natural languages often do not strictly adhere to one syntactic structure. From a descriptivist viewpoint, the linguistic structures of a language evolve over time and across regions. English, for instance, is widely regarded as a “lingua franca” (31) or a “language steamroller” (32), reflecting its widespread international use and the variety of dialects it has spawned worldwide.

**5. Conclusion**

In conclusion, using a SOV or SVO word order as a surrogate to measure syntax acquisition, neither the innate, nor the acquired syntax theories were able to be disproved. This study provided evidence supporting both perspectives. The results were hence consistent with previous research, for which there are proponents – and quasi-evidence - for both extremes of the nature-versus-nurture debate on syntax acquisition. While this study could not reach a definitive conclusion, the results offered a more balanced and intermediary perspective, recognizing the nuance of nature and nurture and how they collaboratively shape linguistic tendencies.

Building on this acknowledgment, an area for further research that could be explored is how the intertwined innate and acquired tendencies of language could influence cognitive processes, as suggested by Slobin’s (1977) theory, which posits that different syntactic structures are driven by varying cognitive motives. How could syntax with which we are native or most familiar with, shape thought and behavior ?

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**Data link to Questionnaire**

https://qualtricsxmvxdgqymbh.sin1.qualtrics.com/jfe/preview/previewId/5b718e7b-9097-46eb-b13a-567c5a7519a3/SV_9pD9R3dueZ8qnv8?Q_CHL=preview&Q_SurveyVersionID=current

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