



# Radboud Universiteit

## The effect of high iconic gestures on L2 noun and verb learning

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## **Abstract**

In order to evaluate the effect of iconic gestures on second language (L2) word learning, an experiment was conducted in which Dutch participants learned Slovak words. All participants learned the same 7 nouns and 7 verbs. They either learned those words while viewing iconic gestures, while viewing and repeating iconic gestures, or while only hearing the words without any gestures. It turned out that, as expected, participants who saw the gestures learned verbs more easily than nouns. This could be attributed to the fact that verbs possibly have a stronger relationship with iconic gestures, creating a more pronounced motoric memory for the words. However, contrary to the expectations, participants in the repeating gesture condition performed worse on the word recall test. Therefore, the theory that producing a gesture during word learning introduces an additional retrieval cue or stronger memory trace because of its motoric modality, is not supported. Possible explanations, implications, and suggestions for future research are discussed.

Keywords: iconic gestures; L2 acquisition; nouns; verbs

## **Introduction**

Although there is no consensus on the exact distribution of the verbal and nonverbal means we use to convey a message, it is evident that the biggest part of human discourse is nonverbal (e.g. Birdwhistell, 1952; Mehrabian, 1972). Therefore, research into nonverbal communication, such as hand gestures, is an important area in communication research.

Generally, gestures are defined as symbolic arm and hand movements related to ongoing talk and to the intention of the message (Kendon, 2004; McNeill, 1992). Any movements that are not related to the message that the speaker intends to convey, like functional actions, (i.e. brushing your hair with a brush), self-regulators, (i.e. touching your hair), or other types of non-verbal behavior (i.e. posture or blushing) are not part of this definition.

Based on this definition of gestures, various categorization systems for gestures have been proposed. Kendon's (2004) categorization of gestures suggests that there is a continuum between various categories of gestures, in which one extreme of the continuum is very dependent on speech and does not have any linguistic properties, while the other extreme is not dependent on speech and does have linguistic properties. This continuum includes

gesticulation (i.e. the hand movements that are made during speech), language-like gestures (i.e. gestures that replace a word), pantomimes (i.e. representational gestures that replace speech, but do not have a fixed form), emblems (i.e. movements that have a specific fixed form or meaning, like the thumbs-up), and sign language (i.e. fixed movements that can fully replace speech). Within the first category (i.e. gesticulation), McNeill (1992) suggested another classification system. This includes deictic, beat, metaphoric and iconic gestures. Deictic gestures are pointing hand movements that aim to refer to something in the surroundings; beat gestures are used to emphasize and structure speech; metaphorical gestures are representational hand movements used to make abstract speech more concrete; and iconic gestures are representational hand movements used to illustrate concrete entities or actions.

These categorizations of gestures allowed for further research into the functions of gestures. For example, Feyereisen (2006) conducted various experiments to assess the different functions of meaningless gestures (like beat gestures) versus meaningful gestures (like iconic gestures) on natural language processing. In his experiments, it turned out that people recalled and recognized more sentences accompanied by meaningful gestures as opposed to meaningless gestures. He concluded that meaningless gestures have an attention function but do not necessarily facilitate memory, while meaningful gestures also have a meaning function, because they add extra meaning to verbal information. Because of their relevant meaning function, iconic gestures have gotten a lot of attention in gesture research (e.g. Beattie & Shovelton, 1999; Hadar & Butterworth, 1997).

Besides the fact that the functions of gestures can be explained based on their category, they can also be explained looking at the person using the gesture. In other words, gestures could be a tool for communication for listeners, and a tool for thinking for speakers (Goldin-Meadow, 1999).

For listeners, gestures can facilitate comprehension of a spoken message and convey thoughts that are not present in speech. For example, Cassel, McNeill and McCullough (1994) conducted an experiment in which listeners had to watch a narration segment and then retell the story. Some narration segments contained some kind of mismatching gestures, while others contained matching gestures. The results showed that everyone who retold the stories took into account the gestures they saw, even when these were contradictory to the spoken words. This suggests that, not only speech, but also gestures are used by listeners to construct

a mental representation of what has been communicated to them. A meta-analysis of 63 study samples confirms that message understanding of a spoken message is indeed improved by gestures (Hostetter, 2011).

A reason for the improved information comprehension in the gesture viewing conditions could be found in the human capacity of learning by observing actions; when we watch others act, our own motor systems in the brain are activated (Buccino et al., 2001). As Ping, Goldin-Meadow, and Beilock (2014) empirically showed, the listener's motor system is, at least partially, responsible for information comprehension, even though it is not entirely clear how this motor system is involved.

Gesture use is not only beneficial for listeners, it is also valuable for speakers. Producing gestures facilitates retrieval of words from memory and reduces cognitive burden (Goldin-Meadow, 1999). For example, in the experiment of Cook, Michell, and Goldin-Meadow (2008), children were presented with math instructions including speech and gesture and were then asked to repeat these instructions. They either had to only repeat the speech, only repeat the gesture, or repeat both speech and gesture. After that, the children had to show how they solved the math problem using the same behavior as in the instruction part (i.e. using only speech, only gestures or both). It turned out that the children who produced the gestures constructed and retained their newly learned knowledge better than the children who only used speech. A reason for the reduction of cognitive burden and the facilitation of word retrieval from memory could, again, be found in the motor modality functions of gestures. As Engelkamp and Zimmer (1985) explained, enactment (i.e. producing gesture) adds something to the memory trace of an event: it makes the trace richer, through which it is easier to recall.

These beneficial effects of producing gestures, however, may not always be as strong in every situation. Huff, Maurer, and Merkt (2018) empirically showed that for procedural learning tasks (e.g. tying a knot) the beneficial effects of using gestures are higher if the use of gestures is congruent during the learning and the testing phase, compared to incongruent use of gesture use. In other words, if people are allowed to produce gestures in the training phase of certain procedural tasks, they are likely to have a higher performance if they also produce gestures in the testing phase, in comparison to not using gestures in the testing phase. They conclude that "gesturing during the learning phase introduces a motor context that may be used as an additional retrieval cue if the same context is available in the testing phase" (Huff

et al., 2018, p. 253). Therefore, not using the learned gestures in the testing phase obstructs learning, because the learner is not able to use all aspects of their mental representations during testing.

### **Gesture use in L2 acquisition**

Because gestures seem to attract more attention, provide extra meaning to speech, contribute to comprehension of a spoken message, facilitate word retrieval, and reduce cognitive burden, they are proposed to not only be beneficial for natural language comprehension, but also to be essential in second language (L2) acquisition. As Gullberg (2006) suggested, gestures play a role in both understanding the L2 learner's acquisition process, as in assisting the learner in its acquisition process.

To show the role of gestures in L2 listening acquisition, Kelly, McDevitt and Esch (2009) conducted an experiment in which twenty adults had to learn twelve Japanese verbs. The words were either presented with only speech, speech with a congruent gesture, speech with an incongruent gesture or with repeated speech. It turned out that participants who were presented with the congruent gestures performed better than the only speech group on a free recall and a recognition test, while the ones with incongruent gestures performed worse. This suggests that gestures do not just enhance learning because they capture more attention, but because they simultaneously communicate the same meaning as speech. Furthermore, the speech and congruent gesture condition produced better word learning scores than the repeated speech condition, which indicates that, even though it looks like both conditions convey the same amount of meaning, the combination of speech and gesture apparently transmits extra meaning. These results about L2 listening are thus consistent with the results found about the L1 information processing (Cassel et al., 1994; Feyereisen, 2006).

Furthermore, the enactment benefits during L1 learning (e.g. Cook et al., 2008) also seem to be important for L2 acquisition. Building up from an earlier experiment by Allen (1995), Tellier (2008) conducted an experiment in which 5-year old children were instructed to either learn L2 words accompanied with pictures or with gestures. The group that saw the gestures also had to reproduce them. It turned out that gestures and their reproduction significantly influenced the L2 memorization of words. Although this does confirm the fact that gestures act as a motor modality, and thus leave a richer trace in memory, it does not allow for assumptions about the differences between gesture viewing and gesture

reproduction. Until now, no empirical studies have focused on comparing the L2 learning results of gesture viewing and gesture reproduction conditions. In other words, it cannot be concluded with certainty that reproducing gestures while learning L2 words is easier than merely viewing the gestures.

Moreover, iconic gestures were not only a frequent studied topic within L1 processing; it has also been researched extensively within L2 acquisition. Macedonia, Müller, and Friederici (2011) conducted an experiment in which native German-speaking people were instructed to learn as many words as possible from a corpus of 92 nouns in an artificial language. They learned the words in four blocks a day, for four days in a row. The blocks differed in their training method, showing either iconic gestures with a face, meaningless gestures with a face, iconic gestures without a face and meaningless gestures without a face. It turned out that, even 60 days after the training, the participants remembered more of the words accompanied by iconic gestures than accompanied by meaningless gestures. Therefore, just as in L1 processing, iconicity is an important topic in L2 acquisition too. It seems that iconic gestures help to create a meaningful mental image of the L2 word and thereby facilitate memory, while meaningless gestures lack this semantic content.

Another topic that has been studied intensively in the area of gesture use and language learning deals with different word types. Besides the fact that gestures can be iconic, spoken words can also be rated on their iconicity (e.g. Perniss, Thompson & Vigliocco, 2010; Perry, Perlman & Lupyan, 2015). In this view, iconicity is taken as “any resemblance between certain properties of linguistic/communicative forms and certain sensori-motor and/or affective properties of corresponding referents” (Perniss & Vigliocco, 2014, p. 2). In other words, for an iconic word, people can create certain conceptual sound-symbolic mappings, meaning that the sound or form of the word somehow relates to a person’s motor or sensory experiences. Perry et al. (2015) and Winter, Perlman, Perry, and Lupyan (2017) found that English verbs generally are more iconic than nouns. In other words, the sound or form of verbs generally relate more to a person’s motor or sensory experience than the sound or form of nouns. Therefore, considering the fact that iconicity facilitates word learning, one would expect that people learn verbs easier than nouns.

However, many studies have shown that children learn nouns earlier and easier than verbs (e.g. Bornstein & Cote, 2005; Gentner, 1982), even in many languages beyond English (Waxman et al., 2013). This could be explained by considering the many other variables,

besides iconicity, that influence early vocabulary learning, like parental input frequency, difficulty of articulation, and concreteness (Massaro & Perlman, 2017). For example, McDonough, Song, Hirsh-Pasek, Golinkoff, and Lannon (2011) suggested that nouns have higher levels of imageability (i.e. a clear mental picture, sound or other sensory experience linked to the meaning of the word; highly correlated with concreteness; Massaro & Perlman, 2017) than verbs. Therefore, these words are easier to perceive as separate and distinct words and they mostly have consistent meanings within different contexts. Consequently, it requires less effort to understand nouns for early language learners.

Remarkably, in word learning trainings accompanied by gestures, this difference between nouns and verbs seems to be reduced. García-Gómez and Macizo (2019) evaluated the role of gestures in L2 word learning in two experiments. In the first experiment, participants were presented with nouns, and in the second experiment, they were presented with verbs. Their results showed a better L2 acquisition of nouns than of verbs, especially in a no gesture condition. However, after further analysis, it turned out that the difficulty associated with the learning of verbs disappeared when congruent gestures were included in the training. This result was explained in the following manner: nouns represent objects or entities, while verbs represent actions or events. Even if certain nouns are represented by movement gestures (such as representing the noun 'lion' by a moving claw gesture), the relationship between verbs and representational gestures is stronger, because they both depict moving actions. As a consequence, gestures seem to facilitate verb learning more than noun learning, reinforcing the theory that motoric information conveyed by gestures is essential for memory performance.

Based on the previous research, the current study aims at investigating four sub-questions, answering the following overarching research question: *To what extent does gesture use facilitate L2 word comprehension?*

The first sub-question is: *Does showing a gesture facilitate L2 word comprehension more than merely saying a word without showing a gesture?*

It is expected that the use of gestures facilitates L2 word learning significantly better than not using gestures at all (H1), as previous research also showed these results (e.g. Cassel et al., 1994; Hostetter, 2011).

The second sub-question is: *Does reproducing a gesture facilitate L2 word comprehension more than merely viewing a gesture?*

Because of the previous research concerning the motor modality function of gestures (Buccino et al, 2001; Engelkamp & Zimmer, 1985; Ping et al. , 2014; Tellier, 2008), it is expected that reproducing gestures facilitates L2 word learning significantly better than viewing gestures (H2).

The third sub-question is: *Is there a difference between L2 verb and L2 noun comprehension?*

Many studies showed that nouns are easier to learn for early language learners (e.g. Bornstein & Cote, 2005; Gentner, 1982), because of, for example, their higher levels of imageability. Therefore, it is expected that, generally, L2 nouns are easier to comprehend than L2 verbs (H3).

The last sub-question is: *Is there a difference in the effect of gesture use between L2 verb and L2 noun comprehension?*

Previous research suggested that verbs are more closely linked to gestures than nouns, making it easier to learn verbs accompanied by gestures than learning nouns (García-Gómez & Macizo, 2019). Therefore an interaction effect could occur between the gesture type and the word type. It is expected that the use of gestures, whether it be viewing or reproducing them, aids more in the comprehension of verbs than of nouns (H4), because of the assumed stronger link between gestures and verbs.

The current paper contributes to the research area of L2 word learning by combining different word types and different gesture conditions into a single method design. Furthermore, instead of using different participants for testing nouns and verbs, as in the experiments by García-Gómez and Macizo (2019), this study will use word type as a within subjects variable to assure validity. The present study aims to investigate whether gesture use facilitates L2 word learning, whether gesture reproduction facilitates L2 word learning more than merely gesture viewing, whether nouns are easier to comprehend than verbs, and whether it is indeed correct to assume that verbs are facilitated more than nouns by iconic gestures, presumably because of their shared function of depicting moving actions.

## Method

*Participants.* Sixty-six Dutch people were selected to participate in the experiment and were randomly assigned to one of the three conditions. Twenty-three participants were in the Viewing Gestures condition, 22 were in the Repeating Gestures condition, and 21 were in the No Gestures condition. Participants were between the age of 19 and 25 years old ( $M = 21.88$ ,  $SD = 1.76$ ). A one-way ANOVA showed that the age was similar across the three condition groups ( $F(2, 63) < 1$ ). See table 1 for the means and standard deviations per condition. Most participants were female (62.1%) as opposed to male (37.9%). A chi-square test showed that the distribution of females and males was similar across the three conditions ( $\chi^2(2) = 1.41$ ,  $p = .494$ ). Educational levels ranged from pre-scientific education to university master levels. Most participants had a university bachelor level (43.9%), and many others also had a university master level (22.7%) or a university of applied sciences level (21.2%). A chi-square test showed that the distribution of educational levels was similar across the three conditions ( $\chi^2(10) = 14.40$ ,  $p = .156$ ).

All participants except for four are born in the Netherlands. Those four participants have lived in the Netherlands for at least seven years. All participants indicated that Dutch was their first language. English ( $N = 8$ ), French ( $N = 2$ ), Chinese ( $N = 1$ ), and Portuguese ( $N = 1$ ) were also indicated as first languages. The participants also spoke second languages, namely English (93.3%), German (62.1%), French (34.8%), Spanish (15.2%), Chinese (3.0%), Italian (1.5%), Portuguese (1.5%), and Swedish (1.5%). Based on their own estimation on their speaking, writing, listening, and reading skills on a scale from 1 to 10, the estimations of their L2 had a mean of 7.63 ( $SD = 2.03$ ) and the estimations of their third language (L3) had a mean of 4.44 ( $SD = 2.93$ ). See table 1 for the means and standard deviations per condition. Also, almost everyone indicated that they used either Dutch, English, or both for reading, watching TV, listening to the radio, and e-mailing or surfing on the internet.

The reliability of the attitude towards L2 learning (comprising of three items, see Appendix C, question 10, 11, and 12) was acceptable:  $\alpha = .73$ . Consequently, the mean of all three items was used to calculate the compound variable 'attitude towards L2 learning'. On a scale of 1 to 10, the average attitude towards L2 learning was 6.10 ( $SD = 1.74$ ). See table 1 for the means and standard deviations per condition.

*Materials.* This research used a 2x3 repeated subjects design, in which the independent variable 'Word type' is a within-subject factor (2 levels: Nouns and Verbs), and the

independent variable 'Gesture condition' is a between-subject factor (3 levels: Viewing Gesture, Repeating Gesture, No Gesture). See figure 1 for a visual presentation of the design.

Seven verbs and Seven nouns have been selected out of a Dutch 400-word list for which the sign translation equivalents have been rated by a group of deaf and hearing signers, and non-signers for the degree of iconicity of a scale from 1 (low iconicity) to 7 (high iconicity) (Ormel, Giezen, Snijders, Schiler & Smoll, in preparation). Only nouns and verbs with an iconicity rating of 6 and 7 were selected. Furthermore, to control for confounding variables, a number of control variables have been considered in the selection of the words. The values per word of some of these variables can be found in table 2. Word length was controlled for, because shorter words are likely to be easier to remember than longer words. Moreover, the level of concreteness was controlled for, meaning that both word types contain concrete words that are based on experience, rather than being abstract language-based words (Brysbaert, Stevens, De Deyne, Voorspoels & Storms, 2014). Furthermore, to control that participants would be familiar with the words, it was made sure that all words were high-frequency (Keuleers, Brysbaert & New, 2010). The frequency of the words differed between the word types, but it was still large enough to propose that the participants were familiar with all of the words (see table 2). Lastly, because Dutch people often speak a good level of Dutch, English and German, any cognates to Slovak words for any of these languages have been left out.

The training materials involved three sets of videos. The first and second set of videos were the Viewing Gesture and the Repeating Gesture condition. In these videos, both a Dutch and a Slovak instructor said the word, accompanied by its ascribed iconic gesture. The third set of videos was the No Gesture condition, in which the instructors only said the words without using any hand gestures. The iconic gestures that were used were the official Dutch signs found on the Global Signbank (2020). To control for recency between conditions, all conditions presented the words in the same order. Details and screenshots of the training videos can be found in Appendix A.

In both the training and testing phase, materials were put in an online questionnaire program named Qualtrics. To test whether participants understood the procedure and remembering the words was not too difficult, eight participants contributed to some pilot tests. Two of them only had one correct answer, one person had two correct answers, one person had three correct answers, two people had four correct answers, one person had five

correct answers, and one person had nine correct answers. Based on the feedback of these pilot tests, it was decided to make the training less difficult by presenting the training video twice and presenting the 14 Dutch words above every video. Furthermore, to make sure the participants would not have to scroll down from the testing video after every word, it was decided that they had to write down their answers on a physical answer sheet before entering them in the online questionnaire. The videos were also perceived as having poor sound quality. However, despite some effort to improve the sound, it could not completely be solved.

*Instruments.* The dependent variable 'Word comprehension' was measured in the test phase of the experiment. The test material also involved a set of videos, which was the same for all conditions. This video only showed the Slovak instructor who did not use any gestures. Also, the words were presented in a different order than in the training phase. Details and screenshots of the testing videos can be found in Appendix A.

*Procedure.* During the experiment, the participants were first explained about the procedure of the experiment, the materials they needed, and their rights concerning the experiment. Then, they were presented with a training video of one of the three conditions. The videos started with an instruction text, displayed for 15 seconds. After that, a screen appeared stating: 'attention: the videos start directly after this page' to make sure participants paid full attention from the start. In all of the videos, two instructors were shown side by side: the left instructor told a Dutch word and the right instructor gave its Slovak translation twice. After every word, there was a break of three seconds before the next word started. To make sure it was not too difficult to learn the words, all fourteen Dutch words were also displayed above the video. After that, they had a small break in which they could fill in a small questionnaire containing questions about their age, gender, educational level, and place of birth. This questionnaire can be found in Appendix B. Then, they were presented with the same training video and Dutch words. After that, they had a small break again in which they could fill in a small questionnaire about their language background. This questionnaire can be found in Appendix C. Lastly, the test phase video was presented. This video again started with an instruction text, displayed for 15 seconds. After that, again, a screen appeared stating: 'attention: the videos start directly after this page' to make sure participants paid full attention from the start. The Slovak instructor told each Slovak word twice. After every word, there was a break of 15 seconds before the next word was told. To make sure it was not too difficult to remember the words, a list of all 14 Dutch words was also displayed above the

video. Furthermore, participants were asked to write down the words on a piece of paper first, before typing them on the online questionnaire, because this was a less time-consuming and distracting option. After the test, participants could see how many correct answers they had.

*Statistical treatment.* To test the effects of the word types and gesture conditions on participant's word comprehension, a repeated measures analysis has been used. Furthermore, to disentangle the effects for verbs and nouns separately, several one-way ANOVAS have been conducted.

Table 1. *The means and standard deviations (between brackets) of the age, the L2 and L3 proficiency (1 = low language proficiency, 10 = high language proficiency), and the attitude towards L2 learning (1 = low attitude, 10 = high attitude) of the participants per condition.*

	Viewing Gestures Condition N = 23 <i>M (SD)</i>	Repeating Gesture Condition N = 22 <i>M (SD)</i>	No Gesture Condition N = 21 <i>M (SD)</i>	Total N = 66 <i>M (SD)</i>
Age	21.96 (1.69)	21.95 (1.89)	21.71 (1.76)	21.88 (1.76)
L2 proficiency	7.49 (1.35)	7.13 (3.08)	8.30 (0.79)	7.63 (2.03)
L3 proficiency	4.17 (2.68)	4.15 (3.19)	5.04 (2.96)	4.44 (2.93)
Attitude towards L2 learning	5.83 (1.77)	6.44 (1.71)	6.05 (1.74)	6.10 (1.74)

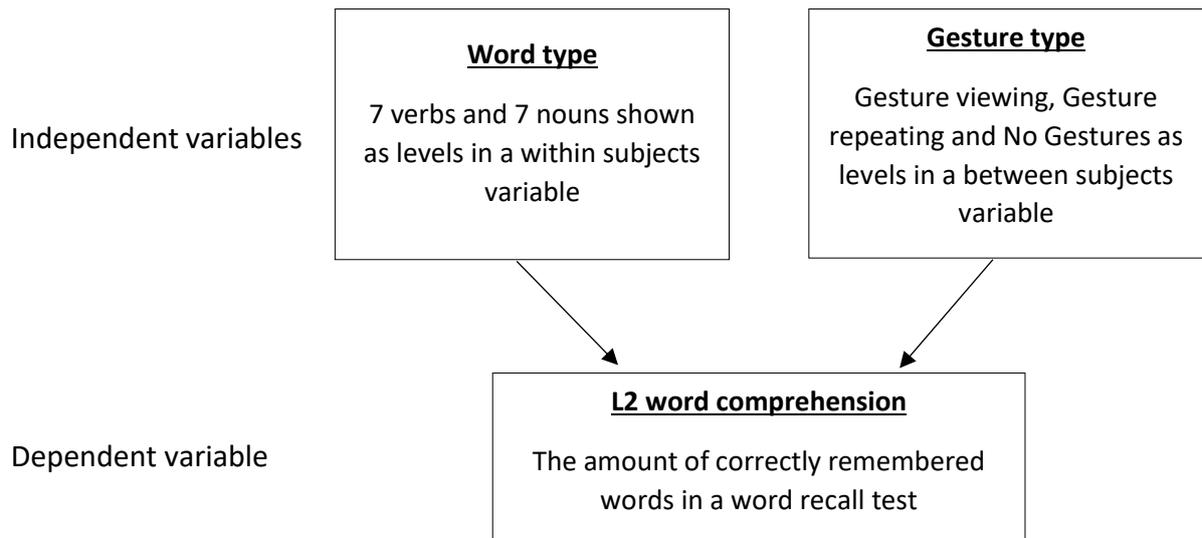


Figure 1. *The analytical model of the research*

Table 2. *The control variables of the Dutch and Slovak nouns and verbs used in the experiment.*

Dutch word	Slovak word	Word length (number of letters of the Slovak word)	Concreteness (1 = abstract, 5 = concrete)	Word frequency (per million words)
<b>Verbs</b>				
Schieten	strielať	8	4.47	132.34
Praten	rozprávať	9	3.87	642.27
Schaatsen	korčuľovať	10	4.47	5.44
Mengen	zmiešať	7	3.80	4.55
Liften	stopovať	8	3.67	2.69
Hardlopen	bežať	5	3.80	2.52
Komen	prísť	5	3.33	1143.88
Average for verbs		7.4	3.92	276.82
<b>Nouns</b>				
Bloem	kvetina	7	4.67	13.49
Wereld	Svet	4	3.33	17.23
Gordijn	záhrada	7	4.67	4.46
Appel	jablko	6	4.67	10.20
Vliegtuig	lietadlo	8	4.80	89.92
Varken	prasa	5	4.80	24.74
Fout	Chyba	5	2.20	68.33
Average for nouns		6.0	4.16	32.62

## Results

A 2x3 repeated measures analysis for word comprehension with word type (verb vs. noun) as within subject factor and gesture condition (Viewing Gesture, Repeating Gesture and No Gesture) as between subject factor showed no significant main effect of word type ( $F(1, 63) = 1.69, p = .198$ ). It did show a significant main effect of gesture condition ( $F(1, 63) = 3.69, p = .030$ ). Independent of the word type, the comprehension score of participants who had to repeat the gestures ( $M = 2.82, SD = 2.94$ ) was lower than that of participants who only viewed the gestures ( $p = .019$ , LSD correction;  $M = 4.87, SD = 3.28$ ) and participants who did not view any gestures ( $p = .025$ , LSD correction;  $M = 4.86, SD = 2.48$ ). There was no significant difference between the comprehension scores of the viewing gesture and no gesture conditions ( $p = .950$ , LSD correction). See table 3 for the means and standard deviations for the comprehension of the words in the three gesture conditions.

There was a significant interaction effect between word type and gesture condition ( $F(2, 63) = 4.83, p = .011$ ). The difference between the two word types was only found among participants who were in the Gesture Viewing condition ( $F(1, 22) = 13.25, p = .001$ ). They had comprehended more verbs ( $M = 2.91, SD = 1.83$ ) than nouns ( $M = 2.00, SD = 1.62$ ). There was no significant difference between the two word types for participants in the Repeating Gesture condition ( $F(1, 21) < 1$ ) and the No Gesture condition ( $F(1, 20) < 1$ ). See figure 2 for a visual presentation of these results.

To disentangle the effects for verbs and nouns separately, two one-way ANOVAs have been conducted. A one-way analysis of variance showed a significant effect of Gesture condition on Verb comprehension ( $F(2, 63) = 5.04, p = .009$ ). Participants in the Gesture Viewing condition had remembered more verbs ( $M = 2.91, SD = 1.83$ ) than the participants in the Repeating Gesture condition ( $p = .008$ , Bonferroni correction;  $M = 1.36, SD = 1.65$ ). The results concerning verb comprehension from the No Gesture condition did not differ significantly from the other conditions ( $M = 2.33, SD = 1.43$ ). A one-way analysis of variance showed no significant effect of Gesture condition on Noun comprehension ( $F(2, 63) = 2.57, p = .085$ ).

To identify a difference between Gestures and No Gestures, the two gesture conditions had been merged into a new variable. A 2x2 repeated measures analysis for word comprehension with word type (verb vs. noun) as within subject factor and gesture condition (Gesture vs. No Gesture) as between subject factor showed no significant main effect of word

type ( $F(1, 64) < 1$ ) and neither of gesture condition ( $F(1, 64) = 1.47, p = .230$ ). There was also no significant interaction effect between word type and gesture condition ( $F(1, 64) = 2.86, p = .096$ ). See table 4 for the means and standard deviations for the comprehension of the words in the two conditions.

Table 3. *Means and standard deviations (between brackets) for the comprehension of verbs and nouns in the three gesture conditions (0 = comprehension of none of the words, 7 = comprehension of all of the words).*

	Viewing Gestures n = 23 <i>M (SD)</i>	Repeating Gestures n = 22 <i>M (SD)</i>	No Gestures n = 21 <i>M (SD)</i>
Comprehension Nouns	2.00 (1.62)	1.45 (1.57)	2.52 (1.44)
Comprehension Verbs	2.91 (1.83)	1.36 (1.65)	2.33 (1.43)

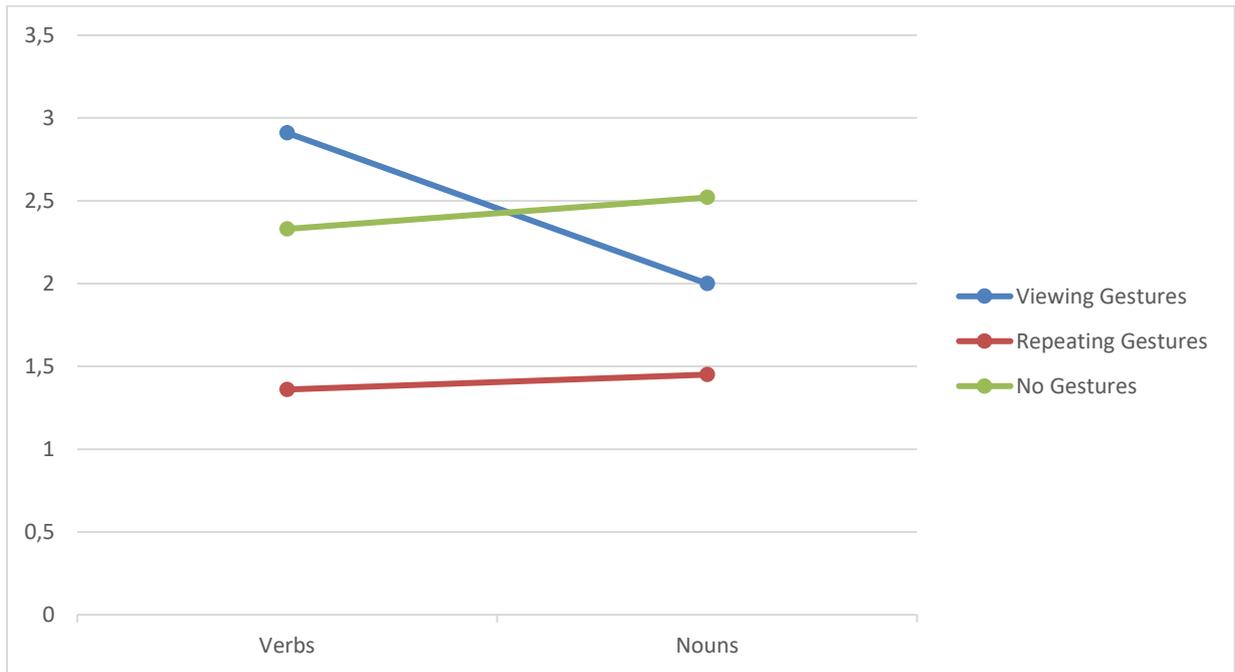


Figure 2. *Comprehension scores of verbs and nouns from participants in the Gesture viewing, Gesture Repeating and No Gesture condition. The y-axis represents the average number of correctly remembered words (0 = no words remembered, 7 = all words remembered).*

Table 4. *Means and standard deviations (between brackets) for the comprehension of verbs and nouns of the merged Gesture condition and the No gesture condition (0 = comprehension of none of the words, 7 = comprehension of all of the words).*

	Gestures	No Gestures
	n = 45	n = 21
	<i>M (SD)</i>	<i>M (SD)</i>
Comprehension Nouns	1.73 (1.60)	2.52 (1.44)
Comprehension Verbs	2.16 (1.89)	2.33 (1.43)

## Conclusion

The goal of the current study was to empirically investigate the effects of gestures on the comprehension of L2 words, differentiating between conditions without gestures, with gesture viewing and with the repetition of the gestures, and including any differences between nouns and verbs.

Firstly, no word comprehension effects were found between the two gesture conditions and the no gesture condition. Therefore, the first hypothesis, stating that it was expected that the use of gestures would facilitate L2 word learning significantly better than not using gestures at all, is rejected.

Secondly, it was found that reproducing the gestures resulted in lower word comprehension than merely looking at the gestures or hearing the words without any gestures. This is the exact opposite of what was expected in the second hypothesis, which stated that it was expected that reproducing gestures facilitates L2 word learning significantly better than viewing gestures.

Thirdly, without taking into account the different gesture conditions, no differences were found between L2 noun and L2 verb comprehension. Therefore, the third hypothesis, stating that it was expected that L2 nouns were easier to comprehend than L2 verbs, is rejected.

However, lastly, a difference between L2 noun and L2 verb comprehension was found among participants that viewed the gestures: they had significantly higher word comprehension scores for verbs than for nouns. This effect was not found for participants who merely heard the words without any gestures, nor for participants who had to reproduce the gestures. Also the separate one-way ANOVAs showed that, only for verbs, the viewing gesture condition resulted in higher word comprehension than the repeating gesture condition. Therefore, the fourth hypothesis, stating that it was expected that the use of gestures, whether it be viewing or reproducing them, would aid more in the comprehension of verbs than of nouns, is partially accepted.

## Discussion

The fact that people generally did not learn more words in the gesture conditions as opposed to the no gesture condition could have various explanations. Firstly, people in the no gesture group seemed to have a higher fluency in their L2 and L3. Perhaps, the ability of speaking another language supports the acquisition of any new languages, like Slovak in this study. Therefore, multilingualism could have cancelled out any gesture effects. Secondly, also quite some people indicated having an extra L1, which could have had an effect on the results. Previous research has indeed shown that cross-linguistic influence exists between a person's L1 or L2 and the acquisition of an additional language, especially when they have an intermediate level or higher (Cenoz, 2013; Tremblay, 2006). People who speak an extra L1 or L2 have potentially developed better learning strategies, have a larger linguistic and intercultural repertoire, and use their extra language knowledge to overcome lexical difficulties in L3 acquisition. Thirdly, especially the participants in the repeating gesture condition had low word comprehension scores. This could have skewed the results of the combined gesture variable. Therefore, it is important to discover the reasons why people in the repeating gesture condition performed worse on the free recall test than expected.

There are two feasible explanations for the weak performance of the repeating gesture condition.

Firstly, despite several attempts of improving the sound quality, the audio of the videos was still very poor, which could have led to an excessive demand of the participants' working memory. The human working memory is characterized by its limited capacity and duration. "Extreme cognitive load causes stress, results in human errors, and limits a human's ability to conduct a given task, especially when the task demands exceed the capacity of the human working memory" (Zhou, Yu, Chen, Wang & Arshad, 2019, p. 289). The capacity can be exceeded by complex tasks, particularly when it includes new information or processing. Furthermore, according to the cognitive load theory, the human cognitive load consists of several load sources, of which one of them is the 'extraneous load'. This refers to the level of working memory load someone experiences due to properties of the used materials (Sweller, Merrienboer & Paas, 1998). In other words, because of the poor audio of the training and testing videos, participants probably used a lot of their extraneous load to listen to the words, undermining their performance of the primary task of learning the words. However, this was the case for all conditions. Therefore, the working memory must only have been overloaded

for participants in the repeating gesture condition. Perhaps, the repetition of the gestures added complexity to the task, demanding more cognitive capacity than the basic task.

Secondly, while participants were instructed to reproduce the gestures during the training phases, they were not able to do this during the testing phase. In procedural tasks, gesture reproduction seems to be more beneficial for participants who are allowed to produce gestures in both the training and testing phase (Huff et al., 2018). Perhaps this also applies to L2 acquisition; the extra retrieval cue created by gesturing in the training phase could possibly only be used if the same context was available in the testing phase.

When it comes to the different word types, the current study supports the claim that gestures have more influence on the acquisition of verbs compared to nouns. Possibly, a strong relationship between verbs and iconic gestures exists, because they both depict moving actions. This relationship is probably weaker for nouns (García-Gómez & Macizo, 2019). Therefore, the relationship between the iconic gestures and the verbs could have created a more prominent motoric memory, and, consequently, facilitated verb learning. Furthermore, the idea that the cognitive capacity of the people in the repeating gesture condition was probably overloaded could explain the fact that the verb-enhancing effects were not found in this condition.

Some limitations of the study should be noted. Firstly, the audio quality of the videos was bad, which made it difficult for the participants to hear the words properly. It demanded extra concentration that could have been used for the actual task. Also, some words might have been easier to hear than others, which could have skewed the results concerning the different word types. Secondly, bilingualism, L2, and L3 proficiency, were not fully controlled for between the three conditions. Therefore, they could have had an effect on the level of difficulty people experienced in learning the Slovak words. Thirdly, the experiment was conducted online, making it impossible to check whether participants did what they were ordered to do. It is imaginable that people did not understand the importance of, or did not feel obliged to, repeat the gestures they saw.

Future research should attempt to discover the implications of gesture use on more word types. This would not only allow for a broader application of gesture use, but it would also present explanations of why gestures would work for some word types, and not for others, providing an increased insight into the mental operations behind gestures. Furthermore, although the issue of the bad audio quality was not intentional, it did motivate

for a discussion about the influence of the human cognitive capacity on gesture use in L2 word learning. Future research could incorporate the measurement of cognitive load, like self-report, performance, physiological, or behavioral measures (see Chen et al., 2016, for a state-of-the-art overview), in the use of gesture production during L2 learning.

In conclusion, gesture use is a very promising tool for L2 acquisition, especially with regard to gesture viewing and verb learning. The current study offers practical insights for L2 educators and learners, and allows for extensive possibilities of further investigation.

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## Appendix A

Details of the training and testing material videos.

Program used: Hitfilm Express

Template: 1080p Full HD

Frame rate: 25 fps

Video width x height: 1920x1080 pixels

File type: mp4

### Video group 1 (Viewing Gestures)

*Instructions: In deze video ga je 14 Slowaakse woorden leren. Je krijgt twee instructeurs te zien: één Nederlandse en één Slowaakse. Eerst zal de Nederlandse instructeur een Nederlands woord uitspreken. Daarna zal de Slowaakse instructeur twee maal de Slowaakse vertaling van het woord geven. Onthoud de woorden goed, want nadat alle woorden zijn geweest zal er een test komen. In deze test wordt verwacht dat je aan de hand van de Slowaakse woorden de Nederlandse vertaling opschrijft. Dit wordt later verder uitgelegd. Voor nu, succes met leren!*

Duration of the video: 00:03:01

### Video group 2 (Repeating Gestures)

*Instructions: In deze video ga je 14 Slowaakse woorden leren. Je krijgt twee instructeurs te zien: één Nederlandse en één Slowaakse. Eerst zal de Nederlandse instructeur een Nederlands woord uitspreken. Daarna zal de Slowaakse instructeur twee maal de Slowaakse vertaling van het woord geven. Onthoud de woorden goed, want nadat alle woorden zijn geweest zal er een test komen. In deze test wordt verwacht dat je aan de hand van de Slowaakse woorden de Nederlandse vertaling opschrijft. Dit wordt later verder uitgelegd. Ook zullen de instructeurs handgebaren gebruiken. Probeer deze, tijdens het leren van de woorden, zo nauwkeurig mogelijk na te doen. Voor nu, succes met leren!*

Duration of the video: 00:03:01

### Video group 3 (No Gestures)

Instructions: *In deze video ga je 14 Slowaakse woorden leren. Je krijgt twee instructeurs te zien: één Nederlandse en één Slowaakse. Eerst zal de Nederlandse instructeur een Nederlands woord uitspreken. Daarna zal de Slowaakse instructeur twee maal de Slowaakse vertaling van het woord geven. Onthoud de woorden goed, want nadat alle woorden zijn geweest zal er een test komen. In deze test wordt verwacht dat je aan de hand van de Slowaakse woorden de Nederlandse vertaling opschrijft. Dit wordt later verder uitgelegd. Voor nu, succes met leren!*

Duration of the video: 00:02:41

### Video testing phase

Instructions: *Nu je de woorden hebt geleerd, gaan we testen hoeveel woorden je hebt onthouden. In deze video zal de Slowaakse instructeur alle woorden twee keer zeggen. Na elk woord heb je 15 seconden om de Nederlandse vertaling op je antwoordenblad te schrijven. De woorden staan in een andere volgorde dan in de vorige video. Succes!*

Duration of the video: 00:04:49



Figure 3. *The word 'schaatsen' in the training video of the gesture conditions on the left and in the no gesture condition on the right.*



Figure 4. *The word 'schaatsen' in the test video*

## Appendix B

The following survey about the demographics of the participants has been used in Dutch.

Now that you have learned the words, you will get a break for a few minutes. In this time, you can already fill in the following data.

1. What is your age?
  
2. What is your gender?
  - a. Male
  - b. Female
  - c. Other, namely:
  
3. What is your educational level?
  - a. WO Master
  - b. WO Bachelor
  - c. HBO Master
  - d. HBO Bachelor
  - e. MBO 4
  - f. MBO 3
  - g. MBO 2
  - h. MBO 1
  - i. VWO
  - j. HAVO
  - k. VMBO
  
4. In case you study, what is the name of your study?
  
5. In case you work, what is your profession?

6. Are you born in the Netherlands?

a. Yes

b. No

If: 6 = a

6a. In which country are you born?

6b. How old were you when you came to the Netherlands?

6c. How many years have you already lived in the Netherlands?

## Appendix C

The following survey about the language background of the participants has been used in Dutch.

Now that you have learned the words, you will get a break for a few minutes. In this time, you can already fill in the following data.

7. What is/are your first language(s)? (multiple answers possible)

- a. Dutch
- b. English
- c. German
- d. French
- e. Flemish
- f. Other, namely:

8. Please, indicate which other languages you know. Write down the languages that you use a lot in daily life or used for a longer period in the past. Try to make an estimation of your proficiency of the language. To do this, use the following scale:

Not good 1 2 3 4 5 6 7 8 9 10 Very good

- a. Language 1:
  - i. Speaking:
  - ii. Listening
  - iii. Writing:
  - iv. Reading:
- b. Language 2:
  - i. Speaking:
  - ii. Listening
  - iii. Writing:
  - iv. Reading:

- c. Language 3:
  - i. Speaking:
  - ii. Listening
  - iii. Writing:
  - iv. Reading:
- d. Language 4:
  - i. Speaking:
  - ii. Listening
  - iii. Writing:
  - iv. Reading:
- e. Language 5:
  - i. Speaking:
  - ii. Listening
  - iii. Writing:
  - iv. Reading:

9. Please indicate which language(s) you use for the following activities:

- a. Reading:
- b. Watching TV
- c. Listening to the radio/music
- d. Email/internet

10. How much do you enjoy learning new languages?

I don't like it at all    1 2 3 4 5 6 7 8 9 10    I really like it

11. How easy do you think it is to learn new languages?

Difficult    1 2 3 4 5 6 7 8 9 10    Easy

12. How often do you use multiple languages during a period?

Almost never 1 2 3 4 5 6 7 8 9 10    Very often