MOTION EVENT EXPRESSIONS IN LANGUAGE AND GESTURE: EVIDENCE FROM HEALTHY AND APHASIC SPEAKERS OF FARSI

BY

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THESIS

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STATEMENT OF AUTHORSHIP

This thesis contains no material which has been accepted for any award or any other degree or diploma in any university or other institution. It is affirmed by the candidate that, to the best of her knowledge, the thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signed Niloofar Akhavan

ÖZET:

Sözlü dil ile jestin bir arada kullanımı ve bunun işlevleri pek çok araştırmanın konusu olmuştur. Bu tezde, (1) eylem içeren olayların jestsel temsillerinin sözlü dil anlatımlarından doğup doğmadığı, (2) sonradan edinilen konuşma bozukluklarının bu jestlerin bilgilendirici özelliğini etkileyip etkilemediği, (3) jestlerin bu konuşma bozukluklarını yansıtıp yansıtmadığı ve (4) jestlerin sözlü dil sistemini destekleyici bir rolü olup olmadığı şeklinde 4 ana soru araştırılmıştır. Çalışmada, Farsça konuşan afazi hastalarının ve sağlıklı bireylerin 20 tane eylem içeren olayı anlatırken kullandıkları sözlü dil ve jestler incelendi. Eylem anlatan olaylarda iki ana unsura odaklanıldı: yol (bir hareketin izlediği yol; örneğin, yukarı) ve hareketin tavrı (hareketin nasıl yapıldığı; örneğin, zıplayarak). Jest ve sözlü dilin, bu çalışmadaki, söz dizimsel özellikler ile cümlecik bazındaki benzerlikleri ve iletişimdeki zamansal sıralamaları çoğunlukla konuşmadaki sözlü dil-jest benzerliğini kanıtlar niteliktedir. Fakat, Farsça konuşan bireylerin sözlü dillerinde hem yol hem hareket tavrı bilgisini kullanırken, jestlerinin hareket tavrı bilgisinden görece yoksun olduğu bulunmuştur. Bu durum sözlü dil ve jest arasında bire bir benzerlik olmadığını göstermektedir. Afazili bireylerle yapılan çalışma ise, jest sisteminin iletişimi devam ettirmek için bozulmamış kaldığını ve bu hastalarda, konuşma bozukluklarının çözümü için etkili olduğunu göstermiştir. Genel olarak, çalışmadaki bulgular, jest kullanımının bire bir sözlü dilden etkilenmediğini, fakat bizzat jest kullanımının iletişim esnasında konuşmada yaşanan bozuklukların giderilmesine yardımcı olduğu bulunmuştur.

Anahtar Kelimeler: eylem içeren olaylar, jest, afazi, Farsça

ABSTRACT

The integration of gesture with speech and its functions have been the subject of a large body of research. In this thesis, we investigate four main questions in this field whether (1) gestural representations of motion events arise from linguistic expressions, (2) an acquired speech disorder affects the informativeness of gestures, (3) gestures reflect the selective speech impairment, and (4) gesture play any role in supporting the language system.We examined the speech and gestures of healthy and aphasic speakers of Farsi during their descriptions of 20 motion events. We focused on two motion event components: path (trajectory of motion like *up*) and manner (how the action is performed like *jumping*). Analyses of syntactic packaging and clause-level correspondence between speech and gesture, as well as parallel ordering of speech and gesture sequences were for the most part, in support of models that posit a close correspondence between speech-gesture productions. However, while Farsi speakers described both path and manner in their speech, gesture was markedly impoverished for manner, suggesting constraints on the one-to-one mapping between linguistic and gestural expressions. The data from aphasic speakers indicated that the gesture system could remain intact to compensate for the communication deficits and also may lead to better resolution of speech problems. Overall, these results indicate that gesture may not be directly influenced by language parameters, but gesturing can compensate difficulties in speech to support the communication.

Keywords: motion events, gesture, aphasia, Persian, Farsi

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Chapter 1

INTRODUCTION

1.1 General Overview

The cognitive architecture and function of co-speech gestures have been extensively studied over the past years. It has been shown that gestures occur across cultures (Kendon, 2004; Kita, 2009), ages (Feyereisen & de Lannoy, 1991), and communicative contexts (McNeill, 1992). Even congenitally blind speakers gesture when they talk to blind listeners (Iverson & Goldin-Meadow, 1998). Children start gesturing at the one word stage of language development (e.g., Iverson & Goldin-Meadow, 2005). Gestures are also used in the cases of speech problems as in patients with aphasia (e.g., Goodwin, 2000; 2005). These findings lend support to the theoretical models of how speech and gesture are coordinated and operate in collaboration.

There are two potential models on the relationship between gesture and speech. One is the Interface Model (Kita & Ozyurek, 2003), which was inspired by Growth Point Theory (McNeil, 1992) and Sketch Model (de Reiter, 2006). According to the Interface Model, gestures arise pre-linguistically during conceptual preparations for speaking and are influenced by language parameters via feedback from linguistic processing. The second is the Lexical Facilitation Model by Krauss and colleagues (2000); assuming that gestures are generated from lexical semantics, and they function to facilitate lexical retrieval. However, there is still debate surrounding these models and their effectiveness (de Ruiter et al., 2013).

This thesis centers on investigating these competing models with two studies. The first study (Chapter 2) focuses on the Interface Model and exploits this model by identifying the effects of linguistic characteristics on gestural behavior. This study examines how gestural representations of motion events arise from linguistic expressions in Farsi, as this language offers many unique characteristics. We examined native Farsi speakers' speech and gestures in describing 20 motion events. Then, we focused on two motion event components: path (trajectory of motion like *up*) and manner (how the action is performed like *jumping*). These are the main two key-motion components, which have been extensively studied in the gesture field.

One important issue in the current gesture models is that they are constructed on the basis of data from healthy populations. Thus it is important to evaluate these models with data different from those that were used to formulate them (de Ruiter & de Beer, 2013). For this reason, the second study (Chapter 3) assesses both models in a population with language impairment. We asked eight Farsi speakers with aphasia to describe the same motion events used in the first study. We focused on three perspectives to distinguish between the two competing models. The first is examining the effect of an acquired speech disorder on the informativeness of gestures in the case of aphasia. The second is investigating if gestures of people with aphasia reflect their selective speech impairment, and finally, the third is examining the function of gestures in relation to their accompanied speech, at both lexical and communication levels.

Finally, Chapter 4 concludes this thesis by summarizing the contribution made to the field of gesture production and opportunities for further work. A list of all stimuli and a scanned copy of neurological assessments used in this research are included in Appendices A, B, and C.

Chapter 2

EXPRESSION OF MOTION EVENTS IN FARSI[1]

2.1 Introduction

The effect of language on thought is considered as either indispensable, such that thought is shaped by one's native language (e.g., Whorf, 1956; Boroditsky, 2001), or as superfluous and existing just when language is recruited to achieve a specific task goal (e.g., Gleitman & Papafragou, 2005; Papafragou, Hulbert, & Trueswell, 2008; Papafragou & Selimis, 2010a). Another approach highlights the cognitive implications of lexicalization patterns in languages. As indicated by this thinking for speaking approach, the thought is provoked by the requirements of a linguistic code. In particular, this theory proposes that the information to be expressed has to be tailored to speaking and must be compatible with the lexical and constructional resources of a given language (Slobin, 1996).

In this paper, we investigate the relation between language and thought by focusing on how Farsi speakers conceptualize motion events in both speech and gesture and the correspondence between these two systems. Languages vary in how they segment and package dynamic motion events and the production of gestures can be susceptible to language-specific aspects, but only during online production of language (e.g., Kita & Özyürek, 2003; Özçalışkan, Lucero, & Goldin-Meadow, 2016, in press). The specific question we pose here is whether Farsi speakers' gestures during describing motion events reflect linguistic characteristics of Farsi in terms of the components they express and the order in which those components are expressed.

[1] This study is published as a proceeding paper by Cognitive Science Society and it is under review in the journal of Language, Cognition and Neuroscience.

2.1.1 Linguistic Representation of Motion Events

Motion events have four semantic components: figure, ground, path, and manner (Slobin, 1996; Talmy, 1985). The *figure* refers to a particular point in space with respect to another object. *Ground* refers to another physical object, which serves as a reference point with respect to which the figure is located. *Path* refers to the translational motion, and *manner* refers to a motor pattern of the movement of the figure. Of these four, manner and path are the focus of the current study. Talmy (1985, 1991) categorizes most of the world's languages into two major types of *Satellite-framed* (S-framed) and *Verb-framed* (V-framed) languages based on how the path of motion is expressed. S-framed languages such as English (Germanic), Mandarin (Sino-Tibetan), and Russian (Slavic), express the manner in the main verb and path with a verb particle or a satellite (e.g., *run down* (the hill*): run* = verb encoding the manner; *down* = satellite encoding the path). The path is occasionally encoded in the verb in English (e.g., she *exited* the building), but these cases are infrequent. On the other hand, in V-framed languages such as Spanish (Romance), Turkish (Turkic), and Hebrew (Semitic), manner is rarely expressed in the verb (e.g., Çocuk *aşağıya yuvarlandı: aşağıya* = preposition encoding the path; *yuvarlandı*= main verb encoding the manner, 'The child rolls down'). Instead, these languages usually express manner in other parts of speech, and sometimes in a subordinated clause (e.g., in Turkish, Çocuk *koşarak* (evden) *çıktı: koşarak* = subordinate clause encoding the manner; *çıktı* = main verb encoding the path, lit: 'The child exited the house runningly'). Path of the motion, on the other hand, is expressed either in the main verb (e.g., exit) or in a verb particle (e.g., go out).

Linguistic data from both adults and children across a variety of languages showcases the typological differences in the description of motion events (e.g., Allen, Özyürek, Kita, Brown, Furman, Ishizuka, & Fujii, 2007; Berman & Slobin, 1994; Choi & Bowerman, 1991; Özçalışkan & Slobin, 2003; Papafragou, Massey, & Gleitman, 2002, 2006; Slobin, 1996a, 2004). These cross-linguistic differences can be used to examine the influence of language on thought. One approach is to investigate how gestural representations of events during speaking (co-speech gestures) differ based on the properties of a given language. This approach is based on the assumption that gestures reflect how events are mentally represented (Clark, 1973; Landau & Jackendoff, 1993; Miller & Johnson-Laird, 1976; Regier, 1996; Talmy, 1983). If such mental representations, i.e., thought, are directly influenced by language, then production of gestures should reflect the properties of the individual's language. If not, co-speech gesture production may deviate from the linguistic characteristics of the utterance accompanying gestures.

2.1.2 Gestural Representation of Motion Events

Co-speech gestures are bodily motions (mainly hands and arms) that accompany speech. These gestures are classified into four main categories: iconic, metaphoric, deictic, and beat gestures. *Iconic* gestures are used as referential symbols to resemble concrete objects or literal actions (e.g., moving the hand toward left to represent 'going left'). *Metaphoric* gestures represent an abstract idea (e.g., moving the hand toward the back of the body to represent past time). *Deictic* gestures are any forms of pointing by any extensible body part (e.g., pointing to an apple with a finger). Finally, *beat* gestures are mere flicks of the hand(s) that adjust to the prosody of the speech without the gesture conveying semantics (McNeill, 1992). Deictic gestures are static (no motion involved), while beat gestures are dynamic (the hand is in motion). Iconic and metaphoric gestures can be of either type. Co-speech gestures are commonly used for communicating information that is visuospatial in nature (Alibali, 2005; Kita & Özyürek, 2003), providing a great deal of information about the internal structure of spatial thought.

There has been an unresolved debate about whether speech and gesture form a tightly integrated communication system or whether they originate from the same representational system or two separate but interrelated systems (Alibali, 2005; Alibali, Kita, & Young, 2000; Butterworth & Hadar, 1989; de Ruiter, 2007; Goldin-Meadow, 2003; Goldin-Meadow & Alibali, 2013; Hostetter & Alibali, 2008; Kita, 2000; Kita & Özyürek, 2003; Krauss, Chen, & Gotfesnum, 2000; McNeill, 1992, 2005; Pouw, de Nooijer, van Gog, Zwaan, & Paas, 2014). For example, Kita (2000) proposed that gestures help to organize and package visuospatial information into units of language. In an extended version of this claim, Kita & Özyürek (2003) proposed the *Interface Model,* which claims that gestures follow the language-specific elements of the sentence they accompany.

Evidence for the Interface Model comes from cross-linguistic studies showing that speakers of different languages produce different gestures for the same concept, and these gestures follow the linguistic structure of the utterances in their language (e.g., Kita, 2000; Kita & Özyürek, 2003; McNeill, 2000; McNeill & Duncan, 2000). Kita and Özyürek (2003) compared English and Turkish speakers' gestural representations to investigate the language-specific encodings of motion events (see also Kita et al., 2007; Özyürek et al., 2005). They found that in cases where there were differences in the semantic and syntactic encoding of motion event elements (i.e., one- versus multi-clause expressions), gestural representations varied in ways that fit the language specific encoding differences. In particular, English speakers produced one conflated gesture to express both elements of manner and path for concepts expressed in a one-clause (e.g., '*running up'* was expressed by a gesture of moving the hand upward while simultaneously alternating the index and middle fingers to signal running). In contrast, Turkish speakers produced two separate manner and path gestures for the same concept, which was expressed in a multiclause in Turkish (e.g., 'going *up runningly*' was expressed by an upward motion of the hand for 'go *up*' and then alternating index and middle fingers for '*run*' without further vertical movement of the hand) (Kita, 1993, 2000; Kita & Özyürek, 2003; Özyürek & Kita, 1999; Özyürek et al. 2005). The developmental trajectory of path-manner packaging is also informative about the language-specific and language-general production of motion event components in speech (Allen et al., 2007) and in co-speech gestures (Özyürek et al., 2008). In a line of research, children speaking S-framed (i.e., English) and V-framed languages (i.e., Japanese, Turkish) were tested using narrations of short animated clips. Allen et al. (2007) investigated the extent to which universal and language-specific patterns played a role in the syntactic packaging of semantic elements of space in early language development. This study distinguished three structural patterns of packaging manner and path information in speech: *Tight, Semi-Tight*, and *Loose* speech.

Tight speech is defined as a compact unit of speech, involving one verb and one closely associated nonverbal phrase (e.g., 'The red guy rolled down.'). *Semi-tight* speech is a unit of speech, involving more than one separate verbal element, one subordinated to the other (e.g., 'The red guy went down, rolling.'). Finally, *Loose* speech contains more than one sentence with no clausal link (e.g., 'The red guy went down the hill. He was rolling at the same time'). Allen et al.'s (2007) results showed that 3-year-old English-speaking children used *Tight* speech more often than their Turkish and Japanese counterparts, whereas Turkish and Japanese-speaking children used *Semi-Tight* packaging more often than English-speaking children, reflecting adult-like patterns of their corresponding languages. However, Turkish-and Japanese-speaking children also used some *Tight* constructions to talk about both manner and path. As discussed earlier, these constructs are allowed but are less frequently used by adult speakers, suggesting that children's early speech shows both language-specific and language-non-specific preferences for packaging path-manner information. These language-non-specific preferences may reflect universal tendencies (Allen et al., 2007). Özyürek and colleagues (2008) examined whether co-speech gestures also follow the same developmental trajectory in packaging manner and path information in English and Turkish. They found that at the age of 3, regardless of their language-specific ways of encoding motion in speech, both English- and Turkish-speaking children produced separate gestures to depict manner and path of motion. However, at the age of 5, children's gestures became more adult-like and showed language-specific patterns (i.e., English speakers used one conflated path + manner gesture whereas Turkish speakers used two separate gestures for manner and path).

In summary, the evidence reviewed above show speakers' sensitivity to language-specific properties both in speech and gesture, as predicted by the Interface Model. Yet, the tight-fit relation between speech and gesture takes time to develop. Young children tend to demonstrate language-non-specific patterns in both speech and gesture. Moreover, these patterns may not correspond well together; young children, irrespective of their native language, are prone to producing *Tight* speech but with two separate manner and path gestures, a pattern different from that predicted by the Interface Model. These findings leave us with a critical question: Is the lack of correspondence between language and gesture only due to developmental factors or is it possible to observe a similar dissociation in adult speakers? We explore this question by examining the correspondence between language and gesture in Farsi, which has different features than languages studied previously.

One other candidate to address this question is examining the word order people use in different languages. In a motion event all elements are presented simultaneously (Figure–Path –Manner–Ground), but the order of using each element in speech is determined by the canonical word order specific to a given language. Goldin-Meadow and colleagues (2008) asked speakers of three Subject-Verb-Object (SVO) languages (English, Spanish, and Mandarin) and one Subject-Object-Verb (SOV) language (Turkish) to perform two non-verbal tasks. In the first task, participants silently described motion events by gesturing while looking at picture displays of vignettes. In the second task, participants reconstructed the event by putting a set of transparent pictures one by one onto a peg to form a single representation. Note that neither task entailed speech production. They found that in both tasks, speakers of all three languages were strongly inclined to use the same agent-patient-action order, which is similar to the SOV pattern in spoken languages. Similarly, others have proposed the independence of gesture order from the canonical word order in speech and found the preference of SOV order among typologically different languages such as Japanese and Korean for gesturing in reversible events (e.g., the girl kicks the boy) (Gibson et al., 2013). These findings suggest that at least certain aspects of gesture production are universal and independent of speech (see also Özçalışkan et al., 2016). However, in these studies no speech was involved, thus, the interaction of word order in speech with co-speech gestures has not been analyzed.

The current study addresses the language and gesture correspondence in a typologically different language: Farsi. As presented above, the question of the sensitivity of gestures based on the structure of the language they accompany has been studied in distinctly categorized S- and V-framed languages such as Turkish and English. Yet, Farsi offers an interesting case to study the link between speech and gesture as it exhibits a mixed typology with characteristics of both S- and V-framed languages, and following a formal SOV but highly flexible word order. In addition, the verbal structure is unique having a small number of manner verbs with a rich set of productive light verb constructs.

2.1.3 Farsi

Farsi (Persian) is the most widely-spoken language of the Iranian branch of Indo-Iranian languages, which is itself a branch of the Indo-European languages. Today, it is primarily spoken in Iran, Afghanistan, and a variation of it in Tajikistan, with large communities of speakers in the countries of the Gulf region. Many of the verbs are compounds, created by combining a light verb (e.g. *kardan* 'to do', *shodan* 'to become', *zadan* 'to hit', which may or may not preserve its original meaning in the compound verb) and a non-verb element (e.g., a noun or an adjective) (Folli, Harley & Karimi, 2005). Examples include *sohbat kardan* (lit: talk to do) 'to talk', *penhan shodan* (lit: hidden to become) 'to hide', *ghadam zadan* (lit: step to hit) 'to stroll'. The non-verb components vary in how much semantic information they convey. Some, like *harekat* 'motion' in *harekat kardan* ('to move') are broad and underspecified, thus, *harekat kardan* can mean any type of motion. Some, like *ghadam* 'step' in *ghadam zadan* ('to stroll'), have more specific semantics, thus, conveying a little more than just the basic action, in this case, walking in a slowly and leisurely fashion. Since many nouns do not carry fine-grained information, details like manner and path are usually left to other parts, such as prepositions and adverbs. These characteristics described above make Farsi a unique case for studying the relationship between language and gesture.

Expression of motion events in Farsi. Using narrations of motion events and following Talmy's typology, Feiz (2011) claims that Farsi exhibits a mixed typology with characteristics of both S-framed and V-framed languages (see also Verkerk, 2014). The similarity to S-framed languages is apparent in cases where path information is expressed in path satellites and manner in a verb as in English. An example is (1) in which *baala* 'up' is a satellite and *davidan* 'to run' is a verb that contains manner information:

(1) [از تپه] بالا دویدن
[az tappe] *baala davidan*
lit: [From hill] up run
'to run up [the hill]'

In terms of syntactic packaging, this is equivalent to a *Tight* package.

The similarity to V-framed languages is in cases where path information is in the verb, leaving manner information to be expressed in other parts of speech, mostly in adverbial that remain subordinate to the main clause as in Turkish (Example 2a).

(2a) دوان دوان دور [...] چرخیدن
davan davan dor -e- […] *charkhidan*
lit: runningly runningly around […] to circle[2]
'running around the […]'

This construct usually manifests as a *Semi-Tight* package, where path is encoded by the verb and manner expressed separately through an "adjunct" or an adverb. Another common form of expressing manner and path is through the use of light verb constructs. Recall that the majority of verbs in Farsi are compounds with a light verb combined with a non-verb element, such as a noun. This mode of manner and path expression can take the form of a main clause and a separate adverbial unit, and create a *Semi-Tight* package (Example 2b):

(2b) لی لی کنان از [...] خارج شدن
ley ley konan az […] *khaarej shodan*
lit: Hop Hop doing from […] exit to become

[2] "Charkhidan" in Farsi in intransitive.

‘To exit the […] in a hopping manner’

“ley ley konan” is an adverb derived from the light verb “kardan” (doing).

In addition, manner and path expression can each manifest as two separate clauses, as shown in an example (3). The latter construct is a *Loose* package.

(3) لی لی کردن. و از [...] خارج شدن
ley ley kardan. Az […] *khaarej shodan*
lit: Hop Hop do. From […] exit to become
‘To hop. To exit from […]’

In summary, there are various ways to express manner and path in Farsi, but the most common way involves the use of light verb structures, which entails *Semi-Tight* or *Loose* syntactic packaging.

Word order in Persian. Farsi is a Subject-Object-Verb (SOV) language in formal sentences. However, the sentential constituents have much freedom to move around in a sentence, especially in the spoken language. A secondary goal of the paper is to see whether the flexibility of word order in Farsi is reflected in people’s spontaneous gesture production.

2.1.4 The Current Study

The current study is the first to investigate how gestural representations of motion events stem from linguistic expressions in Farsi, the unique characteristics of which we reviewed earlier. The paper presents different approaches such as clause level analysis, syntactic packaging, and word order to give a comprehensive account of language and gesture interaction. Farsi speakers are expected to express path of motion with prepositions and manner of motion as verb or adverb together with using light verbs. Our critical prediction concerns the gesture production. If the clause structure of the language corresponds very closely to gestures, as expected by the Interface Model (Kita & Özyürek, 2003; Özyürek et al., 2008), we predict that manner and path will be expressed in a single gesture (i.e., manner and path conflated) when manner and path are encoded in a single clause. In contrast, manner and path should be expressed in separate gestures when they are encoded in multiclause. The paper also analyses how gesture production varies according to type of packaging of manner and path within different linguistic units. According to the Interface Model (Kita & Özyürek, 2003), we predict that: (1) when the speech is *Tight,* there would be one conflated gesture representing both manner and path of motion. On the other hand, (2) when the speech is *Semi-tight* or *Loose* there would be two separate gestures; one referring to the path and the other referring to the manner of motion, as in Turkish. With regard to the pattern of gesture and word order, if gestures are influenced by online processing of language, we would expect the order of manner and path gestures to correspond to the order in which such information is expressed in spoken language.

2.2 Method

2.2.1 Participants

Nineteen monolingual native Farsi speakers (9 females) between the ages of 18 and 30 were tested. Participants lived in Iran, were all right-handed, had normal hearing and vision. All participants signed written consent in accordance with the ethical policies of Koç University Institutional Review Board.

2.2.2 Task and Stimuli

Participants watched 20 dynamic movie clips, depicting different motion events with combinations of 10 manners (hop, skip, walk, run, cartwheel, crawl, jump, twirl, march, step) and 9 paths (between, to, out of, under, over, in front of, around, across, into). Each movie lasted for 3–4 seconds. The clips were previously developed and standardized in English (Göksun, Lehet, Malykhania, & Chatterjee, 2015). All actions were performed by a woman in an outdoor area (see Figure 1 for sample stimuli and for the full list of events see Appendix A). Critically, all events in the experiment could potentially be expressed using both S-framed and V-framed utterances in Farsi.

Figure 1. Sample stimuli from the experimental task. The pictures are still frames from two motion events: jump over (left side) and walk across (right side). The yellow arrows indicate the direction of the person's movement.

2.2.3 Procedure

All participants were tested individually in their home environment in a silent room. They were instructed to watch each clip and then describe what they saw. No explicit instruction regarding gesture use was provided. Before the test trials, two practice trials were administered, and participants received feedback on their performance. Test stimuli were displayed on a Dell laptop in three different randomized orders across participants. The testing sessions were audio- and videotaped. The camera was set in a position to capture the hands and the body of the participants but not the heads.

2.2.4 Coding

Speech. The speech was transcribed verbatim by a native Farsi speaker (first author). The transcribed utterances were coded for the use of manner and path of motion. The pattern of speech responses in terms of manner and path was categorized into groups of manner only (only manner information was expressed in the speech), path only, (only path related information was encoded in the speech) and path + manner together, (both manner and path were expressed in the speech). Manner information was further coded into manner as a verb (4a), an adverb (4b), and the noun in a compound verb containing a light verb (4c):

(4a) Verb	(4b) Adverb	(4c) Noun + light verb
دویدن *Davidan* ‘to run’	بدو بدو *Bodo bodo* lit: runnigly runnigly ‘in a running fashion’	بدو بدو کردن *Bodo bodo kardan* lit: run run to do ‘to run

Path was categorized into path as a preposition (5a), a verb (5b), a verb together with a preposition (5c), a light verb (5d), and a light verb together with a preposition (5e):

(5a) preposition	(5b)Verb	(5c) Verb + preposition
دور *dor –e-* ‘around’	چرخیدن *charkhidan* ‘to circle’	دور چرخیدن *dor charkhidan* lit: around to circle ‘to circle around
(5d) Light verb	(5e) Light verb + preposition	
آمدن *aamadan* ‘to come’	از بین رد شدن *az bein rad shodan* lit: from between pass to become ‘to pass between’	

For the descriptions that contained both manner and path information, we used 2 types of coding: clause coding and syntactic packaging. For clause coding, utterances that included both manner and path were classified based on the clause types: (a) *one-clause* expressions, (b) *multiclause* expressions. The clause coding was adapted from Allen et al. (2007) and Özyürek et al. (2008), who developed the system to test the predictions of the Interface Model.

One-clause expressions involve one verb and one closely associated nonverbal phrase. A typical example of this in Farsi includes a manner verb with a postpositional path phrase, but no path verb, as in Example 6a.

(6a) دختر دور [...] میدود
Dokhtar dore […] *midavad*
lit: Girl around […] runs
'The girl is running around the […]'

In *multiclause* expressions, manner and path were either distributed over separate clauses as path-only or manner-only clauses or one was expressed as an adverb. When path and manner were expressed in separate clauses, manner is described by either a manner verb or manner noun accompanied with a light verb. Path could be constructed by a combination of either a path verb or light path verb with a path preposition. These multiclause expressions are conjoined by discourse markers such as *va* [and] and *baad* [then] in Farsi, as in Example 6b.

(6b) راه میرفت و از روی [...] رفت بالا
'*rah miraft va az ruye* […] *raft bala'*
lit: walk was going and from […] went up
'[…] was walking and went up the […] '

When not expressed in separate path and manner clauses, manner could still be expressed separately as an adverb, along with a path preposition and a light verb, without a manner verb (6c, d) (see Appendix B for more examples). Note that in Farsi, adverbs may or may not be expressed as separate linguistic clauses, but the current coding of adverbial manners as separate clauses allows comparison with previous work testing the Interface Model.

(6c) دختر بدو بدو کنان به سمت [...]رفت
dokhtar bodo bodo konan be samte […] *raft*
lit: Girl run run doing to direction of […] went
'The girl went toward the […] while running

(6d) دختر به حالت بدو بدو به سمت [...] رفت
Dokhtar be halate bodo bodo be samte […] *raft*
lit: Girl in manner run to direction of […] went
'The girl went toward the […] in a running manner'

For syntactic packaging, we examined manner and path information through the linguistic units they are encoded with. Therefore, we classified only the event descriptions that included both manner and path into one of the three categories: *Tight*, *Semi-Tight*, and *Loose*, based on Allen et al.'s (2007) study (see Examples 1-3).

Gesture. For each trial, the number of gestures produced was coded. The gestures were then classified as static or dynamic. Dynamic gestures were further classified into (1) manner only, (2) path only, and (3) path + manner together. Manner only gestures are those that enact the style of a motion without emphasizing the trajectory of the movement (e.g. circular movement of index finger without moving the arm to represent cartwheeling). Path only gestures show the direction of the movement without representing the manner (e.g. movement of index finger in an arc pattern along the horizontal axis from right to left to represent 'across'). Path + manner gestures take two forms: the conflated form contains both components simultaneously (e.g. circular movement of index finger along the horizontal axis from right to left to represent 'cartwheeling across'). The separate form still contains both gestures, but they are performed separately and serially. Figure 2 represents these three types of gestures.

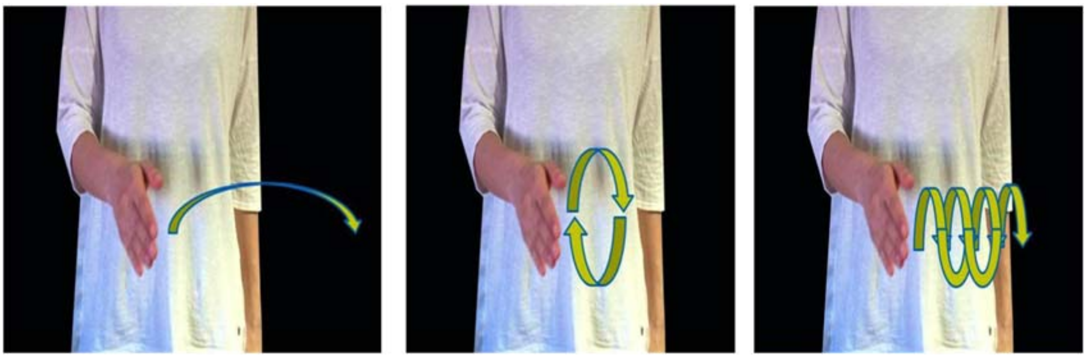

Figure 2. Sample gestures that represent (a) a path only motion (e.g., across), (b) a manner only motion (e.g., cartwheeling), and (c) a path + manner (cartwheeling across).

Word order and gesture. For the path + manner trials where participants generated separate manner and path gestures, we coded the order in which these gestures were produced.

Reliability

To establish reliability for speech, a second native Farsi speaker independently coded 20% of the data. The agreement between coders was 96.4% (n = 80 trials) in assigning manner only, path only, path + manner categories to the descriptions and 90.3% (n = 80 trials) in the segmentation of speech into *Tight, Semi-Tight,* and *Loose* categories. Furthermore, to establish the reliability of the coding system, a second coder randomly chose and mutely coded 20% participants' gestures. The agreement between coders was 97.4% (n = 80 trials) for gesture identification, 90.2 % (n = 80 trials) for gesture category assignment (dynamic or static iconic gestures), and 87.8% (n = 80 trials) for coding gestures that involved manner only, path only, and path + manner.

2.3 Results

A total of 377 trials were included in the analyses. Three trials were excluded because the participant did not provide any descriptions for these. One participant's data was excluded as this person's gestures were out of the camera frame.

2.3.1 Speech Analyses

Participants expressed both manner (*M*= 86%, *SD* = 8.91) and path (*M*=89%, *SD* =12.31) information in their speech and a Wilcoxon signed-rank test showed that there was no statistically significant difference between expressing these components in speech ($Z = -.908$, $p = .364$). Even though manner could be expressed in the verbs, participants expressed manner in adverbial form more frequently than in any other forms (*M*= 75%, *SD* =15.18), X^2 (2, $N = 324$) = 137.35, $p < .001$. One possible reason for this is the difference between colloquial and formal forms in Farsi. Some manner-heavy verbs (e.g., *khazidan* 'crawling') appear more frequently in formal (e.g., in written language) than colloquial language. Avoiding such forms reflects the speaker's choice to use a colloquial style of speaking and remain consistent within that style. However, the same does not hold for all verbs in the set. Some of the verbs that express manner as noun + light verb combinations, e.g., "ley ley kardan" (lit = hop-hop doing) are perfectly acceptable in colloquial Farsi. Nevertheless, speakers' preference for expressing manner in adverbs reflects that even these cases may have been dispreferred in the current experiment. To our knowledge, there are no thorough investigations of the circumstances under which Farsi speakers shift their production from one form to another. Thus, we cannot offer a more conclusive explanation for the observed speech pattern, beyond emphasizing that each sentence in the set could have been expressed in a fashion consistent with either S-framed or V-framed languages, which makes this set distinct from a language such as Turkish. Paths were encoded with preposition + light verb more than any other construct, X^2 (4, $N = 345$) = 554.06, $p < .001$ (see Figure 3 for the use of manner and path expressions in speech).

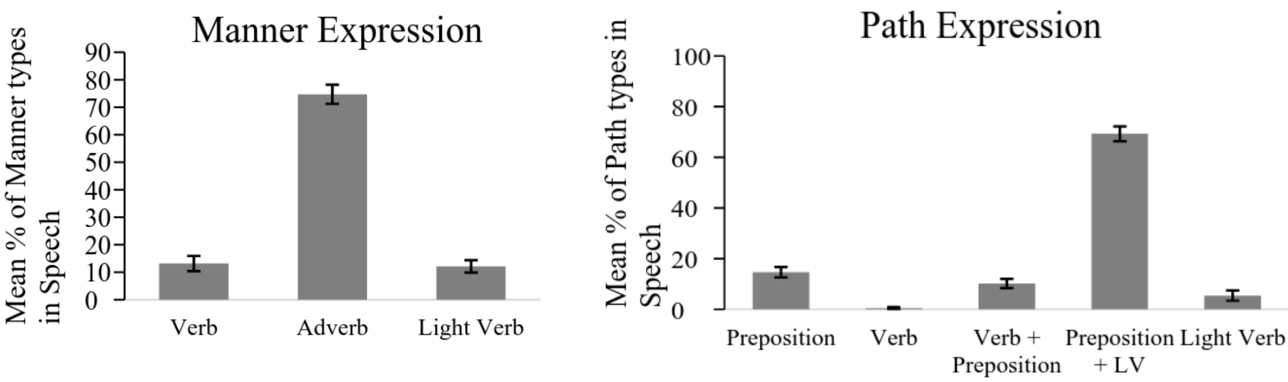

Figure 3. The percentages of manner and path expressions across different speech parts among 377 sentences. The error bars indicate the standard error of the mean.

2.3.2 Gesture Analyses

Participants produced a total of 527 gestures in 298 out of 377 trials. On average, 68% of these gestures were identified as dynamic iconic, 12% of gestures were static iconic and pointing, and 20% as beat gestures. In this paper, we only focused on dynamic iconic gestures that referred to motions in the clips. Participants produced significantly more path gestures than manner gestures or path + manner gesture together (conflated), X^2 (2, N = 358) = 200.47, $p < .001$.

For the trial-based analyses, we coded whether participants used only path, only manner, path + manner (separate) or path + manner (conflated) in each trial. As shown in Figure 4, the majority of dynamic gestures were identified as path only (*M*= 57%, *SD* =15.58) compared to manner only (*M*=12%, *SD* =15.64), path + manner (separate) (*M*=20%, *SD* =16.98), or path + manner (conflated) conflations (*M*=11%, *SD* =13.14), X^2 (3, N = 268) = 164.01, $p < .001$. Participants predominantly produced path gestures that indicated the direction of the movement (e.g., toward the building).

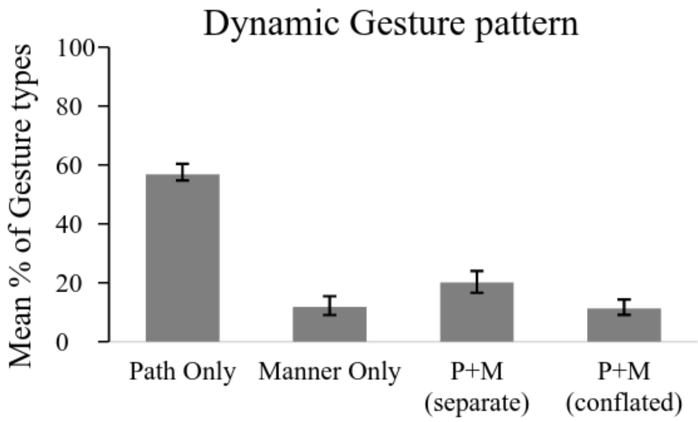

Figure 4. The percentages of path only, manner only, path + manner (separate) and path + manner (conflated) gestures in 268 trials.

2.3.3 Speech – Gesture Relations

To further explore the information represented for motion event expressions, we analyzed whether manner and path were conveyed in both speech and gesture or in one of the two. We found that manner and path were expressed differently in speech and gesture. Participants tended to encode path information in both speech and gesture, X^2 (4, N=377) = 347.92, p < .001, whereas manner was mostly produced in speech only, X^2 (4, N=377) = 369.98, p < .001 (Figure 5).

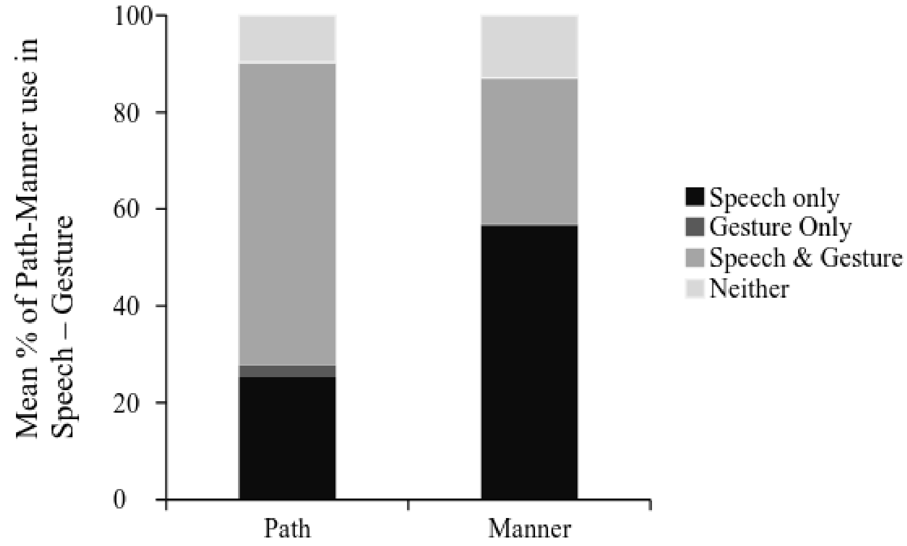

Figure 5. The distribution of the manner and path expressions in speech, gesture, and both.

2.3.4 Gestures in Different Clause Types

Of 277 utterances that included path and manner information, 17 were excluded from the analysis because they were not full clauses with verbs and were interrupted before completion. On average, 43% of these descriptions were encoded by one-clause and the rest (56%) by multi-clause expressions. Moreover, we investigated what type of gestures people produced depending on the clause type, out of all the event descriptions that included both manner and path. The results are summarized in Table 1. In this analysis, we included only data from clauses that were accompanied by dynamic gestures. The results showed that people predominantly produced path only gestures with their one-clause expressions, X^2 (3, N = 89) = 81.29, p<. 001. Such cases are depicted in the example below:

"دختر دور درخت میدود"
Dokhtar dore derakht midavad
lit: Girl around tree runs
'The girl is running around the tree'
Gesture: an index finger moving spherically to represent 'around'

Moreover, according to previous studies, we would expect participants' gestures to overlap mostly with typologically congruent expressions, that is, more manner and path conflated gestures to overlap with one-clause expressions (Kita & Özyürek, 2003; Özyürek et al., 2005). However, the results did not support this. There was no reliable difference between the use of separate and conflated gestures in one-clause expressions, X^2 (1, N = 18) = 0.22, p=.63 (see the example below).

"دختر بپر بپر به سمت در رفت",
Dokhtar bepar bepar be samte dar raft
lit: Girl hop hop to direction of door went
'The girl hopped toward the door'
Gesture: In the case of separate gestures, both hands moved up and down repetitively to represent 'hopping,' followed by one of the hand moving forward on a horizontal axis to represent 'toward.' In the case of a conflated gesture, one of the hands moved up and down repetitively while also moving forward.

In multiclause expressions too, people predominantly used path-only gestures (52%), X^2 (3, N = 171) = 90, p<. 001.An example is given below.

دختر دوید, دور درخت چرخید
Dokhtar davido, dore derakht charkhid
lit: Girl ran, around tree circled
'The girl ran and circled around the tree'
Gesture: the index finger moved spherically to represent 'around'

The results also revealed that the distribution of separate versus conflated gestures differed only in the condition of multiclause expressions, such that there were more separate gestures with this type of expression, X^2 (3, N = 88) = 54.1, p <. 001 (see the example below).

دختر چرخ فلک زد, رفت به سمت خانه
dokhtare charkho falak zado, raft be samte khane
lit: Girl cartwheel hit, went to direction of home
'The girl cartwheeled and went toward home'
Gesture: a circular movement of index finger followed by the index finger moving forward on horizontal axis

Table 1. The distribution of different gestures (path only, manner only, path + manner (separate), path + manner (conflated) and other trials among clause structure (One-clause and

Multiclause) types in all of all the event descriptions that included both manner and path (N=260).

	Path Only	Manner Only	P + M (separate)	P + M (conflated)	Other
One-Clause (n=158)	59	12	8	10	69
Multiclause (n=202)	90	11	51	19	31

2.3.5 Syntactic Packaging and Gesture Types

Another way of looking at the correspondence between speech and gesture is through the linguistic units that manner and path information are encoded by. To investigate whether the syntactic packaging in Farsi affects gestural expressions, we examined the type and pattern of gesture production when both manner and path were expressed in speech. First, in speech, participants used *Semi-Tight* packaging (58%) significantly more than other types: *Tight* (28%) and *Loose* (14%) syntactic packaging, X^2 (2, N = 260) = 76.95 p<. 001. Second, analysis of gestures showed that path + manner (separate) gestures were produced more with *Semi-Tight* packaging compared to *Tight and Loose* packages, X^2(2, N = 56) = 23.56, p< .001. Yet, in both *Semi-Tight* and *Tight* packages, people mostly used path only gestures, X^2(3, N = 123) = 77.43, p< .001 and X^2(3, N = 45) = 29.60, p< .001, respectively. Having only 34 gestures in *Loose* packaged sentences, no significant difference was obtained for gesture type (see Table 2).

Table 2. The distribution of different gestures (path only, manner only, path + manner (separate), path + manner (conflated) and other trials among 3 syntactic packaging (Tight, Semi-Tight, and Loose) types in 260 trials.

	Path Only	Manner Only	P + M (separate)	P + M (conflated)	Other
Tight Package (n= 74)	27	5	6	7	29

Semi-Tight Package (n= 150)	69	9	35	10	27
Loose Package (n= 36)	13	0	15	6	2

2.3.6 Word Order and Gesture Sequence

For this analysis, we included the trials that contained gestures for both manner and path ($N = 58$). Four trials were excluded from the analyses because the speech either lacked path or manner information or the sentence was incomplete. The order of manner and path expressions in gesture and speech (i.e., which one came first) was coded. Results showed that speakers often used gestures for manner information before path information, X^2 (1, $N = 54$) = 46.29 $p<.001$. Similar to the gesture patterns, in 98% of the cases, we observed the same word order sequence in people's utterances.

2.4 Discussion

To our knowledge, this is the first study on motion event conceptualization in speech and gesture in Farsi. We investigated how motion events are expressed in speech and gestures of the native speakers of Farsi, a language that has characteristics of both Talmy's S- and V-framed languages (Feiz, 2011; Verkerk, 2014). Critically, we used this language to test if linguistic variables such as clause structure, syntactic packaging of manner and path information and canonical word order determine the type and order of the produced gestures, as expected by the Interface Model (Kita & Özyürek, 2003).

2.4.1 Motion Event Expressions in Speech and Gesture

Farsi speakers expressed manner and path components of motion events with similar frequency. The manner information was mostly expressed through adverbs, whereas prepositions and light verbs were used more to describe the path of the events. In contrast to speech, participants' dynamic gestures mainly reflected the path and not the manner of motions.

These findings are in line with other results from our lab, which indicate the predominant use of path gestures in contrast to manner gestures among both English and Turkish speakers (Karaduman et al., 2015). Using similar stimuli, we found that both English and Turkish speakers preferred to produce path gestures in tasks involving spontaneous gesture use or gesture-only expressions, regardless of the accompanying speech.

The results of our clause-level and syntactic packaging analyses, which point out the relationship between the processing units of language and gestural representations, provided additional evidence for the relation between gesture and language. Regardless of the clause type expressions (one-clause and multiclause) or syntactic characteristics (mainly for *Tight* and *Semi Tight* packaging) used in the speech, there was a bias for path gesture. Previous research showed that gestural representations were sensitive to linguistic packaging such that English speakers used conflation of manner and path gestures as a result of their *Tight* packaging of path + manner in one-clause. In contrast, Turkish speakers used a combination of manner and path since their speech has characteristics of *Semi-Tight* packaging and multiclause structure (Allen et al. 2007; Kita & Özyürek, 2003; Özçalışkan et al., 2016; Özyürek et al. 2005; Özyürek et al. 2007). Although the expressions in Farsi could take any of the clausal and packaging forms, the predominance of path gestures regardless of linguistic expression of manner and path is not predicted by the Interface Model.

Other aspects of the data, however, can be taken as evidence in support of the Interface Model. First, in the examination of how path + manner gestures overlapped with the two types of clauses, we found that the distribution of separate versus conflated gestures differed in the condition of multiclause expressions. As expected by the Interface Model, there were more separate gestures produced with the multiclause expressions. Second, the findings from the syntactic packaging are in line with the clause analysis; despite the prevalence of path gestures in all types of syntactic packaging, the path + manner (separate) gestures were produced more often in trials where manner and path were separated in two linguistic units (28.5%) (*Semi-Tight* packaging) than trials with *Tight* expression of manner and path information (13.5%).

Why do Persian, Turkish and English speaking participants prefer path gestures to manner gestures? We cannot answer this question with certainty, but we will discuss several possibilities. Dominance of path gestures might be the salience of path compared to manner for event descriptions (Talmy, 2000). According to Slobin (2004) "people are led to focus on and elaborate manner if they use a language with high codability in this domain" (p. 237) Consequently, Slobin attributes saliency differences in encoding motion event components to the lexicalization patterns in languages. S-framed languages tend to include more information about path than V-framed languages. As another categorization system, Ibarretxe-Antuñano (2004a, 2004b) argues that languages regardless of their typological differences can be classified on the basis of their path saliency. Ibarretxe-Antuñano (2009) presented six factors that contribute to the degree to which a given language is high-path-salient: 1) the preponderance of path particles, 2) the final position of verb in the canonical word order, 3) the tolerance for verb omissions, 4) the existence of dummy verbs, 5) cultural systems in which space and motion play important role, and 6) free word order in the oral language. Farsi possesses three of the above factors. First, it stands out by its preponderance of path particles.

Farsi speakers extensively rely on combinations of light verbs and rich set of locative marker prepositions in their expressions of paths. Second, Farsi is a verb-final language. Third, although in Farsi adverbs usually come before the verbs, the other elements of a sentence can move freely around, especially in the spoken language. Thus, Farsi allows expressing path elements in several places in the sentence. On the other hand, manner verbs are few in Farsi, and it has been argued that manner is less salient in languages with limited manner verbs (Matsumoto, 2003, Slobin, 2004, Verkerk, 2013). In short, the predominance of path gestures in Farsi may be in part due to the path-salient nature of the language. However, this explanation does not apply to Turkish and English, in which we found a similar pattern of path predominance in gestures.

The path-bias could also be due to the nature of the videos, in which path information could be more salient than manner information. This would not be the case. People talked about path and manner information in similar frequency. If the stimuli were path prominent, we would obtain more path than manner information in both modalities.

Finally, the predominance of path gestures may stem directly from how people represent events. In event representations, some components are more noticeable than others, which is essential to language production in guiding the mappings between conceptual structures and linguistic systems (Fisher, 1996; Grimshaw, 1981; Pinker, 1989). One example of prominence in conceptual structure is evident in asymmetries between source and goal of motion. In the case of source – goal relationship, children and adults show a ‘goal bias’ as they are more likely to mark the information about goals of motion events accurately than the sources of motion events (Clark & Carpenter, 1989; Fisher, Hall, Rakowitz, & Gleitman, 1994; Lakusta & Landau, 2005; Lakusta, Wagner & Landau, 2007; Papafragou, 2010).

Although some researchers might only interpret this bias as an asymmetry between goal and source of information, this bias can also be regarded as attention to the *path* of an intended goal. For example, Gergely and colleagues (1995) showed that 12-month-old infants looked longer when an agent did not take the most direct path to its intended goal, suggesting the infants were surprised by the failure to directly follow intentions. Furthermore, infant studies also suggest that extracting path information within motion events develops earlier than extracting manner information in non-linguistic dynamic events (Pruden et al., 2012, 2013). Finally, in a study where 2.5-year-old English-, Japanese -, and Spanish-speaking children were tested to construe novel verbs, they highly relied on the path information regardless of their language-specific encoding of manner and path information. Overall, these studies suggest that children prefer salient information in the environment such as *goal – directed* actions or the *path* information that leads to the goal. Taken together, the prominence of path, namely 'path bias', in both speech and gesture could be in part due to the characteristics of Farsi, but most likely also has universal origins in the nature of the representational system. As such, it introduces a new constraint on models of language-gesture interaction that otherwise expect a close correspondence between the utterance and the accompanying gestures.

The present study also investigated the relationship between word order and gesture sequence; a question mostly ignored in the past research. The little work that has explored the issue has demonstrated that the SOV word order emerges even in the gestures of speakers of languages without the SOV constructs, suggesting that there is a cognitive preference for this order (Gibson et al., 2013; Goldin-Meadow et al., 2008; Futrell et al., 2015). Recently, Özçalıskan, Lucero and Goldin-Meadow (2016) tested whether the order of motion elements

(Figure – Ground – Action) found in a particular language affects the way speakers of that language represent the motion events in their gestures with both spontaneous speech production and in gesture only condition. They found that English- and Turkish-speakers displayed cross-linguistic differences in the way they ordered motion elements (Figure-MOTION-Ground vs. Figure-Ground-MOTION) in their speech and gestures, only during online production of language. The cross-linguistic differences did not appear during offline language condition when they produced only gestures without speech. Our results also indicated that gesture sequences followed the same order as their linguistic counterparts during speaking. In describing motion events, manner gestures that were expressed as adverbs in speech occurred before path gestures that were mainly expressed as a combination of preposition and light verbs at the final part of the sentence. This finding is compatible with the role of language-specific encoding on gesture use as claimed by the Interface Model.

To summarize, we found evidence in favor of the influence of language on gesture production as postulated by the Interface model. However, our results also revealed an important constraint on this relationship, namely the predominance of path gestures regardless of the accompanying linguistic construct. These findings call for closer inspection of factors involved in language-gesture interaction.

Chapter 3

PRODUCTION OF GESTURES DURING EXPRESSION OF MOTION EVENTS AMONG PEOPLE WITH APHASIA

3.1 Introduction

Aphasia is a language impairment acquired through damage to the parts of the brain (typically in the left hemisphere), most commonly from stroke, which can cause a communication disorder. The disorder can be specific to some features of the language such as at the level of language production and/or language processing. People with production problems (also known as non-fluent aphasia) have a clear idea about the meaning they want to express while being unable to access the words, and thus, having difficulty to produce the required/intended language. Therefore, those people with production problems have to find alternative ways to compensate their deficits. Using gestures is a functional communicative tool (Butterworth & Hadar, 1989; Hadar & Butterworth, 1997; Krauss & Hadar, 1999; Krauss, Chen, & Gottesman, 2000; Goodwin, 1995, 2000; de Ruiter, 2000; Kita & Özyürek, 2003; Kemmerer, Chandrasekaran, & Tranel, 2007; Lanyon & Rose 2009; Wilkinson, Beeke, and Maxim, 2010; Sekine, Rose, Foster, Attard, & Lanyon, 2013; Rousseaux, Daveluy, & Kozlowski, 2010; Göksun et al., 2013, 2015; Dipper, Pritchard, Morgan, & Cocks, 2015).

The study of gesture production in aphasia is of considerable interest for decades (e.g. Cicone, Wapner, Foldi, Zurif, & Gardner, 1979) as it relates to both theoretical descriptions of language and gesture relations, and has implications for therapies for people with aphasia (PWA). In this thesis, we focused on people with non-fluent aphasia to assess the interplay between speech and gesture from the following perspectives: (1) Examining the effect of an acquired speech disorder on the informativeness of gestures in PWA, (2) Investigating if gestures of PWA reflect their selective speech impairment, and (3) Examining the function of gestures in relation to their accompanied speech, at both lexical and communication levels.

To explore these lines of inquiry, eight Farsi speakers of aphasia were asked to describe short clips of motion events. Their data were coded based on an extensive coding manual and later analyzed using Bayesian single-case statistics (Crawford & Garthwaite, 2007) by comparing to a group of healthy, age-, and education-matched adults. This case statistics method applies Bayesian Monte Carlo methods to determine whether a subject's performance is an observation from the control population, as stated by the null hypothesis. So, if the test indicates that the patient's score is significantly below the average scores of control participants, the null hypothesis can be rejected (Ianni, Cardillo, McQuire, & Chatterjee, 2014).

Before moving to the details of the current study, we will review the current theories on speech and gesture interaction in more detail (Butterworth & Hadar, 1989; McNeill, 2000; Kita & Ozyurek, 2003; Hostetter & Alibali, 2008), and then discuss the related aphasia studies on this issue. We narrow down by reviewing the mechanism of gesture in the presence of specific language deficits, where we finally discuss the role of gesture production for lexical retrieval and communication of PWA. We conclude by addressing the limitations of literature and presenting the methodology and analyses that were used to examine the goals of this study.

3.1.1 Gesture Theories

It is a common viewpoint that gesture and language are not exactly the same processes, but they are linked together. As discussed in the first study, the exact nature of this link is debated by different groups of researchers (e.g., Alibali, Kita, & Young, 2000; Goldin-Meadow, 2003; Kita & Özyürek, 2003; McNeill, 1992; McNeill, 2005; Krauss, Chen, & Gottesman, 2000; Dipper et al., 2015). Currently, there are four well-accepted models on this link, *Growth Point Theory* (McNeill, 1992; McNeill & Duncan, 2000), *Lexical Facilitation Model* (Krauss, Chen, and Gottesmann, 2000), *Interface Model* (Kita & Ozyurek, 2003), and the *Theory of Gesture as a Simulated Action* (Hostetter & Alibali, 2008).

The core of *Growth Point Theory*, developed by David McNeill, is a holistic representation from which an utterance grows. Importantly, this holistic representation contains both imagistic (analogue) and symbolic (discrete) information. This model puts gesture at the semantic level by asserting that all speech-gesture interactions actively construct meaning by filling the role of a psychological predicate (McNeill, 1992; McNeill & Duncan, 2000). According to the *Lexical Facilitation Model* (Krauss, Chen, & Gottesmann, 2000, an idea originally put forth by Hadar & Butterworth, 1997), the primary function of producing iconic gestures (named as lexical gestures[3] in this model) is to facilitate lexical access in speech production. These gestures prime lexical items, increase their activation in working memory and facilitate their access to speech (Butterworth & Hadar, 1989; Hadar & Butterworth, 1997; Krauss & Hadar, 1999; Krauss, Chen, & Gottesman, 2000). According to this model, gestures are formed during lexical retrieval, and because of the lack of the

[3] Lexical gesture is defined as spontaneous, complex, articulate hand-arm movements that seem related to the ideational content of the speech they accompany.

feedback, gestures are not affected by the language parameters or difficulties experienced in the language system. Moreover, this model proposes that the primary function of iconic gestures is not to convey imagistic information to a listener, but rather to facilitate the speaker-internal process of word form retrieval (de Ruiter et al., 2013). The *Interface Model* (Kita & Ozyurek, 2003) suggests that gesture arises pre-linguistically during conceptual preparation for speaking, but is influenced by language characteristics via feedback from the linguistic processing. According to this model a message generator plans speech, whereas, an action generator plans gesture, originating from an interface representation between spatial thinking and speech (de Ruiter, 2000; Kita & Ozyurek, 2003; McNeill, 2000). Finally, according to the theory of *Gesture as a Simulated Action*, speakers naturally simulate perceptual state and action during speech production and gestures are a by-product of simulated actions (Hostetter & Alibali, 2008).

For the purpose of this study, the Interface Model and Lexical Facilitation Model will be assessed by examining the form and function of a gestural representation of PWA while describing the motion events. In the following section, we will review the aphasia literature on the interaction between speech and gesture.

3.1.2 Gesture Production in Aphasia

There is growing evidence of aphasia affecting the frequency of co-speech gesturing, with a body of evidence indicating that as a group, people with aphasia use more iconic gestures per word than healthy controls (Feyereisen, 1983; Hadar, Burstein, Krauss, & Soroker, 1998; Kemmerer, Chandrasekaran, & Tranel, 2007; Lanyon & Rose 2009; Sekine, Rose, Foster, Attard, & Lanyon, 2013; Göksun et al., 2013, 2015). However, others oppose this view, suggesting that gestures tend to degrade with verbal language in aphasia (Goodglass

& Kaplan, 1963; Cicone et al., 1979; McNeill, 1985; Glosser et al., 1986; Mol, Krahmer, & van de Sandt-Koenderman, 2013. In the next section, we present the viewpoints from both sides within two models of degradation and compensation.

3.1.2.1 Degradation Models

In 1870, Finkelnburg introduced a concept of "asymbolia," which proposed that the damage by aphasia extends beyond the speech modality and also causes extraverbal disturbances and general inability to express concepts by means of signs. Later, researchers argued that gesture and language are so closely intertwined in their production process that they also break down together in PWA, and the disturbance of gestures reflects type and severity of verbal deficits in aphasia (Cicone et al., 1979; Glosser et al., 1986). These approaches are compatible with the Growth Point Theory, which suggests that speech and gesture originate from the same representational system. In this system, gesture carries a global-synthetic image of an utterance and speech carries the linear-segmented hierarchical linguistic structure of an utterance (McNeill, 1992; 2005; McNeill & Duncan, 2000).

According to Cicone et al. (1979), PWA with good receptive abilities but non-fluent language production produced few and simple gestures, whereas PWA with poor receptive abilities but fluent language production produced abundant, amorphous, and complex gestures. This pattern was interpreted as a close correspondence between speech and gesture modalities, with gesture production displaying the same characteristics as the verbal output. On the other hand, Glosser et al. (1986) reported that patients with moderate aphasia produced fewer complex and more opaque gestures than patients with mild aphasia and healthy control subjects. Altogether, these support the degradation of gestural expression with severity of the language impairment.

3.1.2.2 Compensation Model

Contradictory evidence came from studies that argued about the compensatory role of gesture in aphasia (e.g., Ahlsen, 1991; Behrmann & Penn, 1984; Beland & Ska, 1992; Herrmann et al., 1988; Le May et al., 1988). Behrmann and Penn (1984) addressed compensation model by showing no clear relationship between gestural communication scores and the severity of aphasia but found that only PWA with nonfluent language output produced pantomimic gestures to replace their speech. Moreover, according to the observation of a patient with progressive aphasia, Beland, and Ska (1992) found that gesture use was increased with decreasing language abilities. Further, Herrmann et al. (1988) reported that PWA employed more gestures than controls to either accompanying their speech or compensating their verbal deficits. More importantly, severe PWA were found to use more codified gestures, such as emblems of direct non-verbal translations consisting of a word or phrase than controls. The authors concluded that even people with severe aphasia could use gestural communication strategies for substituting missing verbal output. Altogether, these studies lend empirical support to the understanding that gestures can function as a communicative device, compensating for reduced language expressions (de Ruiter, 2006). Hogrefe, Ziegler, Weidinger, and Goldenberg (2012) have also recently reported that speakers with severe aphasia tend to employ gestures as a strategy to convey messages, using an alternative means of communication. A follow-up study by Hogrefe et al. (2013) revealed that some speakers with aphasia used gestures spontaneously to compensate for their limited verbal output and these gestures convey more information than the corresponding spoken expression.

In support of the compensation model, Sekine and Rose (2013) reported that the aphasia type and speech fluency have an impact on gesture production. According to their results, the use of concrete deictic gestures and pantomimes were mostly evident in the narratives of speakers with a lower degree of speech fluency. Patients with Broca's and conduction aphasia tended to produce iconic gestures, whereas patients with Wernicke's aphasia used more abstract gestures such as metaphoric or referential gestures. In contrast, those with anomia and transcortical motor aphasia manifested a similar profile of gesture employment to unimpaired control speakers who used fewer iconic gestures. Overall, by showing a specific association between the patterns of gesture production and types of aphasia, they suggested that as linguistic encoding fails in aphasia, individuals rely more heavily on the gesture channel.

From the viewpoints of speech and gesture interaction, the evidence for compensation model from aphasia is in line with the claim that speech and gesture are generated from two separate but interrelated systems. That is, the findings are compatible with both Interface Model and Lexical facilitation Model (Alibali et al., 2000; Kita, 2000; Kita & Özyürek, 2003; Krauss et al., 2000). However, Interface Model and Lexical Facilitation Model have different views on the stage at which gesture comes into play with the language system, and this point is not elaborately discussed in the aforementioned studies. Although, there is a significant body of evidence from cross-linguistic and developmental studies converging on this issue, the case of aphasia provides a unique opportunity to elucidate this debate between speech and gesture, as language can be selectively impaired. Thus, information from each individual may add a lot to distinguish between the two hypotheses outlined above. The next section discusses the studies that have addressed the language profile of speakers with aphasia and attempt to relate it to specific gesture use.

3.1.3 Selective Speech Impairment and Gesture Production

A great deal of research in the literature has shown that in the face of aphasia, damage could be selective to some features of language while others remain intact, meaning that language can be impaired at individual levels of processing (Dippler et al., 2015). Moreover, lesion sites, which are associated with selective impairments of noun, verb or preposition, are known (see the details of these in Miceli, Silveri, Nocentini, & Caramazza, 1988; Miceli, Silveri, Villa, & Caramazza, 1984; Friederici, 1982, 1985; Grodzinsky, 1988; Grodzinsky, 1991; Tesak & Hummer, 1994). The damage can cause difficulty in accessing the words and results in lexical errors, which is common in most aphasia types. Also, the damage can result in the loss of links between words and difficulty in forming a clause structure and causing the PWA to make clause errors (Levelt, 1989). Some PWA manifest both error types and exhibit lexical difficulty as well as clausal difficulty (Dipper et al., 2011).

In order to evaluate the theories of gesture production, it is necessary to investigate whether gestures of PWA reflect their selective speech impairment. To date, only a few studies have assessed selective language impairment in relation to gesture production, in single-case studies (Dipper et al., 2011; Kemmerer et al., 2007) and by larger-scale studies (Göksun et al., 2013; 2015; Dipper et al., 2015).

In the first two single-case studies, speakers with aphasia, whose impairments were at the lexical level, were examined to describe two motion events, "swing'' and ''roll'' from the Tweety and Sylvester cartoon story. For the "roll" event, these patients showed deficits in encoding manner and path information together in a full one clause. Their gestures also reflected their speech by depicting only the manner information separate from the path expression. Thus, these are consistent with the findings of the Interface Model, demonstrating that co-verbal gestures reflect lexical choices made at the moment of speaking. However, the set of data from “swinging” event was also consistent with Lexical Hypothesis (the older version of Lexical Facilitation Model) as the patients in both studies produced a light verb “go”, while they gestured an arc-shaped trajectory to represent “swinging.” In this case, the co-speech gesture functioned to maintain the semantics of “swing” in the lexical-semantic system until a new lexical search was completed, this way the gesture compensated for the impaired language. Hence, the findings from these two sets of case studies were equivocal as to which model is valid.

In a more recent study, Dipper et al. (2015) tested a group of PWAs to evaluate these two hypotheses. They used the same key events of “roll” and “swing” to identify whether PWA’s gesture production reflects their impaired verbalization in terms of the semantic content and structure. This time, their results were in favor of Interface Model as they found correspondence between the semantic content of gesture and spoken language in PWA at the lexical level. Moreover, gestures had a compensatory role when the language was absent (Kita & Özyürek, 2003; Özyürek et al., 2008; de Ruiter’s, 2000; 2006). However, in terms of the clausal structure, their data was indicative of no relationship between speech and language, because when the speakers with aphasia used such structures, they accompanied their verbal description with gestures depicting only path information. One drawback of their work was neglecting the fact that their participants had different types of aphasia.

In another patient group study, Göksun and colleagues (2013) contributed to this notion by presenting neural evidence for the link between spatial language and spatial gesture. They examined the neural basis of naming spatial relations and the relationship between impaired verbalization of spatial relations and spontaneous gesture production. Using voxel symptom-lesion mapping analyses, they showed that the focal brain injured patients with damage on the left posterior middle frontal gyrus and the left inferior frontal gyrus had impairments in naming prepositions, but did not produce gestures to compensate. Other researchers also reported that gestures and language processing recruit overlapping areas in the left inferior frontal gyrus and damage to this area would result in both linguistic and gestural impairments (Willems et al., 2007; Dick et al., 2014, 2009). Yet, this study did not show a compensatory mechanism between speech and gesture considering the region of the lesion. In a further study, Göksun et al. (2015) investigated the verbal and spontaneous gestural representations in the same stroke patients by asking them to describe motion events. In terms of the link between speech and spontaneous gestures they provided support for the compensatory role of gesture for verbal impairments, and thus, validated the Interface Model (Kita & Özyürek, 2003; Özyürek et al., 2008). In particular, damage to the left superior temporal gyrus was associated with higher gesture production to compensate for impairment in inferring the information about the path of a motion event. The data for these two studies came from patients with a focal lesion at their left hemispheric, but they were mostly anomic rather than having fully impaired speech.

As it is evident from the previous discussion, there are still mixed results on how speech and gesture as two separate modalities emerge and operate in collaboration. To date, gesture scholars have attributed different functions for the gesture, which can be used here to assess the theoretical part of speech – gesture integration models. The following section details the main functions of gestures and discusses how they can add to the theoretical description of language and gesture relationships.

3.1.4 The Functions of Gestures in Aphasia

Gestures are usually classified based on their type and relationship to speech content (See Ekman and Friesen, 1969; McNeill, 1992 for details of their classifications). The most widely used classification includes four types of gestures: deictic, metaphoric, iconic, and beats (McNeill, 1992). However, the form and function of these gestures are not clearly differentiated in this classification, which makes gesture investigations limited. For example, in the above classification, deictic gestures and beats are classified based on their function during the co-occurring speech, whereas other gesture types are coded in relation to the gesture forms or patterns of gestural movement (Kong et al., 2015). Later, other researchers studied each gesture type and expressed their functions in relation to the accompanied speech. For instance, Butterworth and Hadar (1989) studied iconic gestures and suggested that these representational gestures facilitate word finding process by providing an alternate route to the lexicon. Subsequently, they introduced the function of assisting lexical retrieval for iconic gestures (see Mayberry & Jaques, 2000; Beattie and Shovelton 1999 for further evidence). Goldin-Meadow (1998, 2003) studied deictic gestures extensively in children and adults and found that these gestures have functional value for both the speaker and listener. Deictic gestures are reported to help speakers by lowering the demand on their cognitive resources and also benefit listeners' comprehension of the messages by means of pointing or illustration of the objects in the real world (see Goldin-Meadow 2003 for a full discussion on this issue). Beat gestures, already identified as rhythmic gestures in the McNeill's classification, are known to be associated with the flow or rate of the speech without carrying any semantic content. Nevertheless, these functions are not definite and can vary in other conditions, or their functions can be interpreted differently as a result of using a different coding manual. To overcome this limitation, Kong et al. (2015) introduced a coding system that independently classifies and quantifies gesture forms and functions.

In the dimension of functions, Kong et al. (2015) classified gestures into eight categories: (1) providing additional information to the carried message, that is, the content of the gesture gave additional information related to the speech (adapted from Goldin-Meadow, 2003), (2) enhancing the language content—gestures that signal the same meaning as the language content and potentially ease the decoding of language content by listener (adapted from Beattie & Shovelton, 2000), (3) providing alternative means of communication—gestures that carry meaning or information that are not included in the language content (adapted from Le May et al., 1988), (4) guiding and controlling the speech flow—gestures that reinforce the speech rhythm with the rate of gesture movement synchronized with the speech pace (taken from Jacobs & Garnham, 2007), (5) reinforcing the intonation or prosody of speech—gestures that involve a speaker's amplifying or highlighting a target element in the speech, (6) assisting lexical retrieval—gestures that facilitate lexical access at times of word-finding difficulty (adapted from Mayberry & Jaques, 2000), (7) aiding sentence re-construction—gestures used when a speaker demonstrates modification of syntactic structure or refinement of sentence structure (adapted from Alibali, Kita, & Young, 2000), and finally (8) no specific function—gestures that do not exhibit a specific function in relation to the language content or serve unclassifiable functions other than the ones mentioned above. In another study, Kong et al. (2015) compared the distribution of different gesture forms and functions between the healthy speakers and PWA and reported that gestures with semantic content (iconic, metaphoric, deictic gestures, and emblems) enhanced language content and provided additional information to the language content of PWA. As for the non-content carrying gestures, beats were primarily used for reinforcing speech prosody or guiding speech flow, while non-identifiable gestures were associated with assisting lexical retrieval or with no specific functions (Kong et al., 2015).

Understanding these functions has important clinical implications for gesture-based language therapy in aphasia. These functions can be involved in therapeutic approaches by two ways: training gesture to replace the speech (to provide alternative means of communication), or using gestures to cue the speech (to assist the lexical retrieval). Besides, the use of gesture as compensation of speech or facilitator of lexical retrieval can actually contribute to the theoretical debate about the relationship between the speech and gesture modalities.

Using compensatory gestures would enhance the communication and benefit the listener's comprehension. However, gestures are not simply produced for the benefit of the listener, but they support the speaker, which fits with the formulation of Lexical Facilitation Model (Krauss, Chen, & Chawla, 1996; McNeill, Cassell, & McCullough, 1994).

To understand the facilitative role of gestures for speech retrieval, researchers employed therapy-based studies (e.g., Boo & Rose, 2011; Raymer et al., 2006; Rodriguez, Raymer, & Rothi, 2006; Rose & Douglas, 2008). These studies suggest that naming therapies incorporating a gestural cue can significantly enhance both noun and verb production. However, as treatments combined verbal and gestural elements, it is difficult to determine the independent contribution of gestures.

To examine the potential role of gestures for helping language production in healthy adults, researchers have used the gesture prevention paradigms. The performance on language production tasks is usually deteriorated when gestures are prevented (Hostetter, Alibali, & Kita, 2007, but see Beattie & Coughlan, 1999). However, these paradigms require active inhibition of gestures that would have otherwise been naturally produced and diversion of attention from the main task of speaking, thus, causing confounds in the testing setup. To overcome these limitations, Akhavan et al. (2016) investigated the same issue by exploring the relationship between disfluency in speech and gesture use in healthy speakers. They found that while gestures are not specialized for resolving overt problems in speech, different types of gestures were employed on disfluent trials to facilitate communication in different capacities. One possible explanation for the link between gesture and lexical retrieval could be that gesturing may lighten the verbal working memory (VWM) load (Goldin-Meadow et al., 2001). It has been also shown that speakers with lower VWM capacities produce gesture more often than those having higher VWM capacities (Gillespie et al., 2014). Thus, gesturing may free up VWM resources that are recruited during speaking. However, these studies only report an increase in lexical gestures during instances of disfluency in language production (Butterworth & Beattie, 1978; Morrel-Samuels & Krauss, 1992) and the outcome of gesture use for word retrieval is not known yet.

Taken together, there are inconsistencies in the existing literature of speech and gesture investigation. The reason behind the inconsistent outcomes could have different reasons. First, patients' profiles differ based on their medical history, severity, and lesion site. Additionally, most of the previous studies have not controlled for the presence of limb apraxia as a result of a stroke. Limb apraxia is a neurological disorder of motor control that might co-occur in severe aphasia and could disrupt various processes necessary for imitating gestures, the production of meaningful gestures on command, and the actual use of tools and objects

(Goldenberg, 2009). Especially in group studies, it is difficult to have a homogenous dataset of patients with comparable aphasia types and severity.

Second, in several studies different techniques are used for gesture elicitation. Among them, semi-structured interviews, free conversations, and narrative retelling are very common (Lausberg et al., 2000; Rose & Douglas, 2003; Kemmerer et al., 2007; Dipper et al., 2011; Dippe et al., 2015). There are two major problems with these tasks: (1) it is difficult to control the influence of a partner in semi-structured interviews and free conversations (Hogrefe et al., 2013). As also indicated by Cicone et al. (1979), “There is a strong, almost irresistible tendency on the part of another conversant to supply contexts where the aphasics can usefully exploit their meager linguistic and gestural repertoire” (p. 346). (2) Narratives place a significant demand on general cognitive skills like attention and memory (Duinmeijer, de Jong, & Scheper, 2012).

Third, studies up to date have used different approaches to analyze gestures. Most of the previous studies are quantitative (Feyereison, 1983; Hadar, Burstein, Krauss, & Soroker, 1998; Kemmerer, Chandrasekaran, & Tranel, 2007; Lanyon & Rose 2009; Pedelty, 1987; Sekine, Rose, Foster, Attard, & Lanyon, 2013; Göksun et al., 2013, 2015) and there is less qualitative work to assess the speech-gesture relationship (Mol, Krahmer, and van de Sandt-Koenderman, 2013). Finally, most of the previous studies do not account for the communicative context and function of the gesture production (Kong et al., 2015; 2015).

3.1.5 The Current Study

To shed light on the limitations and inconsistencies on the link between speech and gesture, we asked eight individuals with non-fluent aphasia to describe short clips of motion events. We later analyzed their data using single-case statistics by comparing to a group of healthy, age, and education matched adults. More specifically, the type of PWA that we focused on in this study had the following characteristics: (1) their produced speech showed problems, (2) their descriptions, even if reduced to single words, were used in a coherent way, (3) their speech perception was less affected than speech production, and (4) other neurological impairments that could be caused by stroke, such as limb and speech apraxia were absent.

We examine the link between speech and gesture, mainly comparing Interface Model and Lexical Facilitation Model. We ask whether (1) an acquired speech disorder affects the informativeness of gestures, (2) gestures reflect impaired spoken language in a similar way, and (3) gesture play any role in supporting the language system of PWA. Regarding these questions, the following predictions were made:

(1) According to the assumptions of the Interface Model, gestures produced by PWA would be informative despite the lack of information in their speech. The Lexical Facilitation Model does not have much to say about the informative content of the gestures.

(2) In line with both the Interface and Lexical Facilitation Models, when PWA have difficulty accessing the path and manner information in lexical forms, more gestures arise which are semantically relevant to their speech. Moreover, in line with the Interface Model, when the speech is intact, the produced gestures would reflect the linguistic parameters of the spoken language.

(3) According to the Lexical Facilitation Model, the production of meaning-laden gestures would maintain the semantic representations at the conceptual level, which results in

lexical retrieval. This model assumes that gestures are produced for the benefit of the speaker and they do not have a communicative value. On the other hand, the Interface Model predicts that gestures are produced to organize the speech and compensate for the speech impairment with the ultimate goal of enhancing the communication of PWA.

3.2 Method

*3.2.1 **Participants***

Twenty-one right-handed participants with left hemisphere brain damage were recruited from the patient list of Tabasom Stroke Rehabilitation center in Tehran, Iran. The data from twelve patients were excluded because of the following reasons. Six of the patients manifested difficulty in comprehending the instructions and were unable to complete the tasks. Moreover, they had limbic impairments, which were apparent in their limb apraxia test scores. Three of the patients suffered from speech apraxia and another three were recovered from aphasia and their current aphasia score did not indicate any deficits. One patient’s aphasia type was conduction. One of the patients was Persian – Azari bilingual and one participant’s data was excluded as this person’s gestures were out of the camera frame. Overall, the data from eight individuals were used for the final analyses. Table 3 provides an overview of the demographic and clinical characteristics of the patients. All participants were native Persian speakers. All of them had traumatic brain damage resulting in the focal lesion. All participants were at least twenty months post-onset of the brain damage. None of the patients had a history of other neurological disorders, psychiatric disorders, or substance abuse, without any vision or hearing impairments. Eleven age- and education-matched elderly healthy adults participated as a control group. All subjects gave informed consent to participate in the study in accordance with the policies of the Koç University Institutional Review Board.

Table 3. Demographic information on aphasic participants (*N* = 8)

Patient	Aphasia Type	Gender	Age	Years of Education	Lesion site	Cause	Stroke post-onset time (in months)	WAB (AQ)	Apraxia (AQ)
P-1	Broca's	F	50	12	L	Stroke	69	56.7	100
P-3	Broca's	M	64	0	L	Stroke	45	47.5	85.7
P-4	Anomic	M	62	16	L	Stroke	44	80.8	100
P-5	Broca's	F	27	12	L	Stroke	49	42.5	88.5
P-6	Anomic	M	56	16	L	Stroke	33	50.8	100
P-8	Broca's	M	72	16	L	Stroke	51	64.2	93.1
P-10	Broca's	M	73	12	L	Stroke	28	46.7	89.4
P-14	Anomic	M	43	16	L	Stroke	22	95.8	100

3.2.2 Task and Stimuli

3.2.2.1 Clinical Assessment

The *Bedside Aphasia Battery* (B-WAB) (Nilipour, Pourshahbaz, & Ghoreyshi, 2014) was administered to all patients. It is a shortened version of the Western Aphasia Battery-Revised, and consists of five linguistic subtests: spontaneous speech content and fluency, auditory comprehension, sequential commands, repetition, and naming categories (see Appendix A for the Farsi version of the B-WAB).

The *Limb Apraxia Battery* adapted for Persian was assessed by a pantomime-to-command task (Nilipour, under review). Participants were asked to mime the use of 20 common objects (e.g., brushing teeth with toothbrush). The examiner showed the photograph of the object and named the action/ the object simultaneously. Participants were videotaped for the whole clinical assessment session.

3.2.2.2 Stimulus Material

The same stimuli as in Chapter 2 were used.

3.2.3 Procedure

All participants were tested individually in the clinic at Tabasom Stroke Rehabilitation center. First, WAB and then Apraxia tests were administered. The rest of procedure was the same as indicated in the Procedure section of Chapter 2. Data collection including clinical assessment and the experimental testing was conducted within a time frame of 2 hours for each individual.

3.2.4 Coding

The important step in this patient study was to devise a reliable manual for coding speech and gesture with respect to form, function, and quantifying how they may be related. Below, the coding system for each question of interest is outlined. All the responses (speech and gestures) were transcribed and coded by a native Farsi speaker. Gesture coding was done manually by the same person using the ELAN software package (Brugman & Russel, 2004).

3.2.4.1 The Informativeness of Speech and Gestures

First, speech and gesture were coded separately. Participants' speech in each trial was transcribed and coded for *speech informativeness*: accurate and non-repetitive phrases excluding errors and disfluency were coded as informative. Speech informativeness was then calculated as the duration of informative speech over total speech time on each trial. Instances of disfluency were coded based on these categories: a) filled pauses (e.g., *uh* and *um*, *er* and *ah*), b) repetitions (e.g., the girl is *running*, *running* around the tree), c) fillers and comments (e.g., *What's the word I need …* when used in the middle of a sentence while searching for a word). The errors detected here were semantic in type ('cat' for 'dog').

In the next step, participants' spontaneous use of gestures in each trial was coded for *gesture informativeness,* which was defined as non-repetitive event-relevant gestures excluding random hand flicks or gestures with no representational meaning or referent. Gesture informativeness was then calculated as the duration of informative gestures over total gesture duration on each trial. According to Kendon (1972), gestures can be segmented into qualitatively different movement phases of "Preparation -> Hold -> Stroke -> Hold –> Retraction". These phases make a gesture unit. But in all these phases, stroke phase is obligatory. Thus, if one gesture passes the preparation, but did not follow by the stroke, then that duration was coded as non-informative. For example, when the participants saw the event in which woman was running around a tree, an informative gesture response would be making a circle in a gesture to represent –around- while moving the index and middle fingers to represent -running- without over repetition or interruption.

3.2.4.2 Selective Impairment of Speech and Gesture

Participants' speech was coded for the *accurate expressions* of manner and path information in each trial. Later, the pattern of the expressions for manner and path was categorized as manner only (only manner information was expressed in the speech), path only, (only path related information was encoded in the speech) and manner-path together (both manner and path were expressed in the speech). Further, *type of manner-path expressions* was coded. Manner information was coded into manner as a verb, an adverb, and the noun in a compound verb containing a light verb and path expressions were categorized into path as a preposition, a verb, a verb together with a preposition, a light verb, and a light verb together with a preposition (see section 2.2.4 for complete definition and examples). Here, by manner and path together, we do not refer to path + manner conflation[4]. It refers to trials where both types of information were expressed.

Gestures were coded for the *comprehensibility* of dynamic gestures for manner and path components of motion events depicted in the clips. We further classified each dynamic gesture into three types: a) manner only, b) path only, and c) manner and path (see section 2.2.4 for complete definition and examples). Here, by manner and path, we do not refer to path + manner combination or conflation. It refers to trials where both types of information were expressed.

3.2.4.3 The Functions of Gestures

The speech and gesture were coded in parallel for the instances in which PWA had word retrieval difficulty, and whether they used gestures or not. The outcome of lexical retrieval difficulty with respect to gesture use was then compared. For example, when a participant had trouble retrieving the word 'hopping', we looked if a relevant manner gesture (e.g. moving both hands up and down to represent 'hopping') emerged before the speech problem was resolved or not.

Moreover, each spontaneous gesture that appeared in the descriptions of motion events was independently coded for the 6 functions (partially adapted from Kong et al., 2015): (a) matching (e.g., mimicking the action of cartwheeling with the hand while producing the word), (b) early reinforcement (e.g., mimicking the act of running with fingers while struggling to retrieve the word 'run' that was eventually produced), (c) compensatory (e.g., when the speaker drew a circle with the index finger to represent 'around' without producing

[4] There were no instances of gesture conflation.

the corresponding word), (d) complementary (e.g., when the speaker mimicked the act of running with fingers followed by drawing a circle to represent ‘running around’ while saying the word ‘run’ without verbally expressing the path of event ‘around’), (e) interactive gestures (e.g., when the speakers reveal the palm of the hand to indicate uncertainty or having nothing to say), and (f) redundant (gestures that carry no semantic information, e.g., raising and lowering the hand during or in-between verbal expressions). This way, the frequency of each gesture type and their functions were obtained for each participant.

3.3 Results

PWA produced a total of 366 gestures in 151 trials and controls had a total of 108 gestures in 226 trials. On average, 62.6% of PWA’s gestures were identified as dynamic, iconic, 9.8% of gestures were static iconic, 15.9% as beat gestures, 9.8% as palm hand, and 1.91% as deictic. The controls’ gestures compromised 72.6% dynamic, 11.1% beat, and 9.3% static gestures. One trial of one PWA was excluded because she did not attempt to describe it in any mode.

3.3.1 The Informativeness of Speech and Gesture

To test whether gesture and language reflect operations of a single system or two separate systems, we first examined if gesture informativeness varies with informativeness of speech. The analysis was run at the level of each individual patient using Bayesian single-case statistics (Crawford & Gartwaite, 2007). Results revealed that PWA’s speech was significantly less informative than that of controls, but their gestures were not (Table 4).

Table 4. Single case statistics profile of PWA ($N = 8$) for informativeness of speech and gestures.

Patient	**Informative speech %**	**Informative gesture %**
01	46**	68
03	12**	39
04	27**	66
05	22**	42
06	25**	85
08	25**	87
10	0**	62
14	72**	75
Control group average (*N*=11)	92	76
SD	4.4	25

Two-tailed probability of $p < .05$ **

3.3.2 Selective Impairment of Speech and Gesture

Overall, the control group performed near the ceiling in their verbal descriptions of motion events (see Table 5). Moreover, they used fewer gestures in their descriptions (see Table 6). Results of the Bayesian single-case statistics for verbal expressions for path information in the PWA group revealed a severe deficit among 5 participants. These patients were significantly impaired in encoding any path information in their speech compared to controls, *p*s < .05 (see Table 4). We then ran the same analysis for verbal expressions of manner information and found that 7 patients were significantly impaired compared to control, *p*s < .05 (see Table 5). Moreover, these analyses revealed that the verbal impairment of patients 03 and 04 were specific to manner expressions and for path expression the same patients showed no difference compared to controls. Further, the single-case analysis did not reveal any significant differences between PWA and controls for the *types* of manner and path expression.

Table 5. Single case statistics profile of PWA for expression of path information in different types.

Patient	**Preposition %**	**Verb %**	**Verb + preposition%**	**Light verb%**	**Light verb + preposition %**	**None %**
01	0	0	0	0	0	100**
03	17	0	0	11	11	61
04	11	0	11	6	17	56
05	0	0	0	0	0	100**
06	6	0	0	0	6	89**
08	10	0	0	5	10	75**
10	0	0	0	0	0	100**
14	48**	0	0	5	43	5
Control group average(*N*=11)	14	0	13	5	53	14
SD	10.41	1.44	11.73	6.74	26.39	20.51

Two-tailed probability of $p < .05$ **

Table 6. Single case statistics profile of PWA for expression of manner information in different types.

Patient	**Verb%**	**Adverb%**	**Noun + Light verb%**	**None%**
01	0	22	17	61**
03	11	0	0	89**
04	6	6	6	83**
05	0	10	15	75**
06	6	0	11	83**
08	15	0	10	75**
10	0	0	0	100**
14	0	57	33	10
Control group average (*N*=11)	12	43	35	8
SD	11.23	25.39	19.46	6.99

Two-tailed probability of $p < .05$ **

We then evaluated whether PWA with spatial verbal deficit can depict spatial information in their gestures. Bayesian single-case statistics revealed that except patient 14, all other PWA had fewer manner and path expressions when compared to healthy controls. The results point out a significant impairment of spatial language of 7 PWA (see Table 7).

Table 7. Single case statistic profile of PWA for the production of spatial language.

Patient	Path only%	Manner only%	Path & manner%	None%
01	0	33	0**	67**
03	33**	6	6**	56**
04	33**	6	11**	50**
05	0	25	0**	75**
06	6	11	6**	78**
08	15	15	10**	60**
10	0	0	0**	100**
14	14	5	81	0
Control group average (*N*=11)	11	16	71	2
SD	7.04	17.17	21.99	4.70

Two-tailed probability of $p < .05$ **

Next, we examined whether the impairment was evident in PWA's gestural expressions. The production of spatial gestures was also tested at the level of an individual patient using Bayesian single-case statistics. Results indicated that 5 PWA produced significantly more spatial gestures than controls to express manner and path information (see Table 8).

Table 8. Single case statistic profile of PWA for the production of spatial gesture.

Patient	Path only%	Manner only%	Path & manner%	None %
01	39	17	39**	6
03	28	17	22	33
04	11	11	72**	6
05	5	30**	40**	25
06	6	11	83**	0**
08	40	30**	15	15
10	21	16	32	32
14	48	5	43**	5

Control group average (*N*=11)	15.57	5.40	8.33	70.69
SD	15.27	7.00	11.11	30.05

Two-tailed probability of $p < .05$ **

It is likely that PWA use gesture to compensate for their impaired language. To understand whether gesture reflects the specific impairments of spoken language or compensate verbal information, the data of each individual for specific speech impairments and gesture production was studied exclusively. As a result, the specific mechanism of gesture use in relation to speech impairment among PWA is addressed in the following four main categories:

a) General speech and gesture impairment

In this category, each patient was observed to see if they show a general deficit in their speech and gesture. Bayesian single-case statistics indicated no significant evidence among any patient for the general deficit in both speech and gesture systems. The impairments were specific to the speech, $p > .05$.

b) Speech general impairment and gesture compensation

Bayesian single-case statistics showed that patients 01, 05, 06, 08 and 10 had general impairments to verbally encode manner and path, ps < .05. However, they represented this information in their gestures by producing significantly more manner and path gestures.

c) Specific speech impairment compensated by specific gesture type

We found that patients 03 and 04 had specific impairments to encode manner information and single-case analyses revealed that these patients employed more manner gestures than path gestures, $p < .05$. However, their gesture employment was not specific to their speech deficit.

d) No general speech impairment

Bayesian single-case statistics confirmed that patient 14 had no specific deficit in verbally expressing manner and path. His speech was not different than controls. However, his gesture production dissociated from controls as he employed relatively more manner and path gestures.

3.3.3 The Functions of Gestures

Here, the functions of gestures for language system first at the lexical level and then at the communication level were analyzed.

Do gestures facilitate lexical retrieval? To answer this question, we first looked at all the cases where there was a speech problem, i.e., 'lexical retrieval difficulty.' Then, we conducted an analysis on whether these problematic cases were accompanied by a meaning-laden gesture or not, and whether these cases became resolved or not. For trials with gestures, the gestures' onsets were before speech resolution, and they were also semantically relevant to the retrieved word. If gestures had facilitated lexical retrieval, we would have expected significantly more problematic cases to be retrieved that contained a gesture than those without a gesture. Healthy individuals did not show traces of production problem in their language. Thus, this analysis was conducted among PWA without comparing to control group. Among 152 trials, a total of 408 speech problems were identified. Figure 6 presents the distribution of speech problem cases with respect to gesture use and outcome.

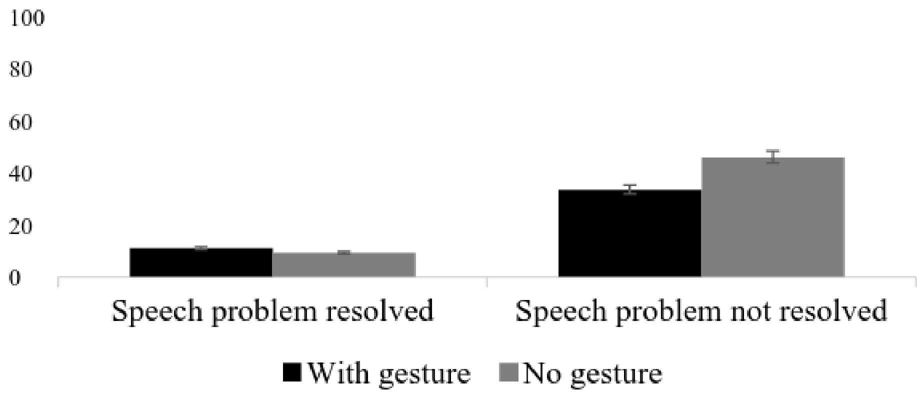

Figure 6. Distribution of speech problem cases.

Results revealed that the extent to which speech problem cases were resolved was contingent on whether or not gesture was used, X^2 (1, N = 408) = 3.89, p <.05).These findings imply that gesture production benefit PWA at lexical retrieval level.

The previous analyses showed that gestures were functional at the lexical level, then what other functions did they serve at the communication level? The functions of gestures during event descriptions were tested at the level of individual patients and compared to controls using Bayesian single-case statistics (Table 9). The results demonstrated that only two PWA (participants 03 and 05) produced significantly more redundant gestures (e.g., random hand flicks, or over repetition of the same gesture unit) than controls. Moreover, except participants 03 and 05, all other patients employed interactive gestures significantly more than controls in their descriptions. By analyzing the compensatory gestures, we found that gestures matched speech rather than compensated for absent speech in healthy speakers (63% vs. 0%), whereas the pattern was reversed in aphasia with more compensatory than matching gestures (31% vs. 14%). This finding supports the claim that speakers might employ meaning-laden gestures to compensate for diminished language content for listeners. Finally, results revealed cases where gestures produced earlier than retrieved words to facilitate the comprehension of the listener at times of word-finding difficulty by providing the information in gesture before the verbal units are produced (mostly evident in participants 01 and 04).

Table 9. Distribution of functions of gestures employed in PWA (*N* = 8) and normal speakers (*N* = 11) in percentage value.

	Early reinforcement %	**Matching %**	**Complementary %**	**Compensatory %**	**Interactive %**	**Redundant %**	**Total number of gestures**
01	20**	14	0	25	19**	22	69
03	4	8	0	18	15	55**	50
04	15**	0**	9	40	25**	10	65
05	5	2	5	31	7	50**	42
06	8	4	8	56	20**	4	50
08	5	29	0	19	40**	8	21
10	0	0**	0	62	21**	17	21
14	4	54	4	0	22**	16	50
Control group average (*N*=11)	3	63	19	0	4	11	12
SD	4.6	27.7	29.6	0.0	6.3	13.8	10.1

*Two-tailed probability of p < .05 ***

3.4 Discussion

The study of gesture production is of considerable interest for aphasia, as it contains important implications for therapeutic approaches as well as feeding theories on language and gesture relationship. The literature suggests two potential links between gesture and language: (1) gesture arises during conceptual preparations for speaking according to the Interface Model or (2) gestures are generated from lexical semantics as stated in the Lexical Facilitation Model. The current study assesses these competing theories in light of three main inquiries: (1) whether an acquired speech disorder affects the informativeness of gestures, (2) whether gestures reflect impaired spoken language in a similar way, and (3) How using gesture can help PWA. Our results indicate that the gesture system in PWA is intact, and serves compensatory roles in a way that enhances the communication at times of language production difficulty and facilitate the impaired speaker with lexical retrieval. Despite the limitations of both models, our results demonstrated supportive evidences in of favor the Interface Model and the Lexical Facilitation Model.

To reach this conclusion, single-case analyses were conducted on the data of eight PWA describing short clips of a motion event. We used the same events to test Farsi speakers' expression of motion event in both speech and gesture, as indicated in Chapter 2. It was found that Farsi speakers expressed manner and path components of motion events with similar frequencies. The manner information was mostly expressed through adverbs, whereas prepositions and light verbs were used more to describe the path of the events. In contrast to speech, participants' dynamic gestures mainly reflected the path and rarely the manner of motions. The upshot of that work indicates evidence in favor of the influence of language on gesture production as postulated by the Interface Model. However, the results also revealed an important constraint on this model, namely the predominance of path gestures regardless of the accompanying linguistic parameters. Altogether, by using an established set of stimuli and a comprehensive coding manual, a new investigation considering the correspondence between speech and gesture in PWA was conducted here.

We first asked if gesture degrades with speech, or can be compensatory. The results showed that all PWA's speech was significantly less informative than that of non-aphasic speakers, but their gestures were not. The current results are consistent with the case studies of Goodwin (1995, 2000), which suggest that the message PWA try to communicate is not impaired, but they have trouble transferring it effectively. To convey complex information, it is suggested that PWA use multimodal communication (gestures) to compensate for their affected verbal skills (Goodwin, 1995, 2000; Wilkinson, Beeke, and Maxim, 2010; Herrmann, Reichle, Lucius-Hoene, Wallesch, & Johannsen-Horbach, 1988; Rousseaux, Daveluy, &

Kozlowski, 2010). On the other hand, these results appeared to contradict the claims by Cicone et al. (1979), Glosser et al. (1986), and Mol et al. (2013), who suggested that gestures tend to degrade with verbal language in aphasia. For example, according to Mol et al. (2013), gestures produced by PWA are less informative than those produced by neurologically healthy speakers. In other words, they suggested that speakers with aphasia might not necessarily compensate for their impaired verbal expressivity by gesturing. Yet, their conclusions may be confounded by the factor of limb apraxia, because they did not disentangle the influence of limb apraxia on gesture production in their severely aphasic subjects. Taken together, the current findings indicate an intact gesture system in PWA, which serves mainly as an alternative to verbal communication and accommodates well with the Interface Model. However, this analysis does not help us to distinguish these theories because Lexical Facilitation Model does not have much to say about this finding (see below for the discussion on how two models differ in explaining the selective impairment of speech and gesture).

From a closer look at the units of information encoded in speech and gesture, our data show that PWA mostly rely on gestures for the impaired verbal expression of spatial information. As indicated from the data of five PWA in this study, manner and path gestures were mainly produced when the speaker had deficits to encode them verbally. This is consistent with both the Interface Model and Lexical Facilitation Model. The Interface Model illustrates this connection by arguing that there is a feedback mechanism between speech and gesture, where in the presence of speech difficulty the action generator turns on and represents the event through gestures (Krauss et al., 2000; de Ruiter, 2000; Hostetter & Alibali, 2008, 2010; Kita & Özyürek, 2003). On the other hand, the Lexical Facilitation Model does not indicate a feedback mechanism, but posits that in the case of lexical retrieval difficulty, gesture provides the semantic boost while a new conceptualization is carried out (Hadar & Butterworth, 1997). These two models match well with the data from these five patients when considering the lexical retrieval difficulty and gesture compensation mechanism.

There are two points in the data that conflict with the Lexical Facilitation Model. First, one of the patients displayed intact verbal abilities to encode manner and path, similar to speech profile of controls. However, his rate of spatial gesture production was similar to other patients and different from controls. Second, two other patients showed specific language impairments to encode manner, yet, their gesture production was not specific to this problem as they had comparatively similar frequencies of manner and path gestures. These findings support the Interface Model over the Lexical Facilitation Model. According to the assumptions of the latter model, gestures merely arise in response to lexical retrieval difficulty, and in such contexts, the gestures provide the key information. Thus, this model does not account for the overproduction of gesture in the absent of speech difficulty. In contrast, the Interface Model provides a feedback loop mechanism for the gesture to either reflect linguistic choices made in times of language problem (light language paired with a light gesture) or to compensate for them (light language paired with a rich gesture). Both models are similar in that gestures come online to compensate the speech impairment for manner and path verbal expressions.

Nevertheless, the current results did not show any evidence regarding the syntactic effect of language on gesture as proposed by the Interface Model. The data from controls demonstrate that their dynamic gestures mainly reflected the path, not the manner of motions. This pattern is inconsistent with Kita and Ozyurek's version of the Interface Model, in which the lexical choice affects the gesture. Results from healthy Farsi speakers indicated the predominance of path gestures regardless of the syntactic packaging of spoken language. Nevertheless, data from PWA of the current study cannot follow the same analysis, as their verbal expressions were severely impaired. Thus, there were a few instances of full clause formation for manner and path information. Altogether, the data from young and elderly healthy adults presented here do not guarantee the influence of language parameter on the gesture, as postulated by the Interface Model.

We then turned to the question that has been a focus of many past studies: What is the functional role of gestures for speech production and how can our findings add to the theoretical debates of language and gesture relationships? We examined this issue, first from lexical retrieval perspective, and then from the level of communication.

Data from the instances of the lexical retrieval difficulty revealed that the presence of the gestures make a difference in the outcome of the retrieval difficulty. As suggested by Krauss' Lexical Facilitation Model, we observed more instances of retrieval difficulty to be successfully resolved when accompanied by lexical gestures. This model assumes that producing lexical gestures facilitates the retrieval of phonological word forms from the mental lexicon during speaking (Hadar & Butterworth, 1997; Krauss, 1998; Krauss, Chen, & Gottesmann, 2000). Likewise, our results indicated facilitation for the speech production of speakers by means of gesture employment in a damaged system. Other studies in support of the Lexical Facilitation Model have only shown evidence for the link between lexical gestures and verbal fluency. These studies only reported an increase in lexical gestures during instances of disfluency in language production (Butterworth & Beattie, 1978; Morrel-Samuels & Krauss, 1992) and others proposed that utilizing gesture inhibition paradigms yield to deterioration in verbal output (Rauscher, Krauss, & Chen, 1996; Rime & Schiaratura, 1991). In addition, some researchers rely on the gesture–word temporal distance and the prevalence of iconic gestures to provide support for the Lexical Facilitation Model (Lanyon & Rose, 2009). However, the often reported association between speech difficulty and lexical gesture frequency is insufficient to support for the Lexical Facilitation Hypothesis, as there are other alternatives and plausible explanations for why people would gesture more when they have language production problems (de Ruiter, 2006; 2013). One explanation could be that while the speaker is experiencing trouble finding the word, gestures keep the floor, helping to find the appropriate verbal form (Beattie & Coughlan, 1999). The other possible explanation is that the speaker is compensating for the failing verbal communication by using the gesture. The spatial gestures that would facilitate retrieval of the correct word for the speaker could also do the same facilitation for the listener. Altogether, the findings of the current study support Krauss' Lexical Facilitation Model, by demonstrating that the PWA's gesture production was higher during instances of speech production difficulty, which were helpful in the speech resolution processes.

Moreover, using a detailed coding system, we analyzed how each gesture contributed to the description of motion events. Among all gesture types, iconic gestures (both dynamic and static) matched the language content among healthy speakers (63%). Only in 19% of the cases, gestures enhanced the language content of speech among these speakers. The PWA group, on the other hand, used iconic gestures to convey the spatial information to the listener in the absent of any verbal output. This confirmed the notion that gestures could be used to compensate for naming problems in aphasia and help the speaker to convey the message, consistent with contentions of the Interface and Lexical Facilitation Models (also see Göksun et al. 2013, 2015). Moreover, for two patients, gestures were produced earlier than the retrieved word. In such cases, the lexical items for information (in this case, manner and path) might have become difficult to access due to the impairments, but still present in the conceptual route. The available conceptual representation exerts a semantic influence on the accompanying gesture before, regardless of whether the speaker can access to the spoken form of the intended word (e.g., adverb for manner, preposition + light verb for path expression). This process (message appeared initially in gesture and transferred to speech) is another type of the compensation mechanism proposed by the Interface Model. This compensatory act could have comprehension benefits for the listener and facilitates the flow of the conversation. Taken together, gesture production serve multiple purposes for PWA as also proposed by Lanyon and Rose (2009). Gesture can facilitate the process of word retrieval at times of speech difficulty, and also great deal of iconic and interactive gestures can be used by PWA to compensate for breakdowns in verbal expression. The results from this analysis favor both Interface and Lexical Facilitation Models.

The PWA in the current data set produced many interactive gestures. These gestures do not carry semantic information and are mostly in the form of pointing, beat, and palm hand. But they are valuable for the speaker because they are used to achieve a “successful conversation” by managing the interaction. These gestures maintain the interaction by bringing the listener into the conversation or by indicating uncertainty or having nothing to say (Bavelas et al., 1992). As a result, gestures can be used in a number of different ways as an interactional resource in conversation.

Taken together, to understand the interplay between the speech and gesture, data from aphasia need to be analyzed by qualitative, detailed and multimodal methods as carried out in the current study. This paper presents a new dataset from Farsi speakers with aphasia while they described motion events. The results show that gesture system is mostly intact and can compensate for the impaired language in different ways, by retrieving the lost word, conveying the content of the message, facilitating the comprehension of the listener, and maintaining the conversation. These findings are important both clinically and theoretically, and they support Interface Model and Lexical Facilitation Model despite the constraints that each model inherits.

CHAPTER 4

CONCLUSION

4.1 General Conclusion

To understand the relationship between speech and gesture, it is required to study different populations and languages (Yammiyavar, Clemmensen, & Kumar, 2008; de Ruiter, 2013; Kong et al. 2015). This gives a comprehensive overview of the different representations and processes that are assumed to underlie the production of gesture and speech. This thesis presents a new dataset from healthy and aphasic speakers of Farsi when they were describing motion events. Farsi offers an interesting case to study the link between speech and gesture as it exhibits a mixed typology with characteristics of both S- and V-framed languages, and following a formal SOV with a highly flexible word order. In addition, the verbal structure is unique to having a small number of manner verbs with a rich set of productive light verb constructs.

In the second chapter, we studied healthy Farsi speakers to investigate if linguistic variables such as clause structure, syntactic packaging of manner and path information and canonical word order determine the type and order of the produced gestures, as expected by the Interface Model (Kita & Özyürek, 2003). Altogether, analyses of clause-level and syntactic packaging correspondence between speech and gesture, as well as parallel ordering of speech and gesture sequences were mostly in favor of the Interface Model. However, these findings suggested constraints on the one-to-one mapping between linguistic and gestural expressions as Farsi speakers produced a path in both speech and gesture, whereas manner was conveyed predominantly through speech.

In the third chapter, we tested aphasic Farsi speakers for the informativeness and functions of their gesturing to assess the competing models of the speech-gesture link, namely the Interface Model and the Lexical Facilitation Model. Results indicated that the gesture system could remain intact to facilitate the lexical retrieval and compensate for the communication deficits in PWA. Thus, our results fit with both of the models.

It should be noted that the gesture models that we discussed in this study are formulated mainly on the basis of observations and experimental data obtained from speakers without language impairments. Hence, some aspects of their assumptions may not apply to a damaged system. By further developing these models, we can better understand and predict the aphasia phenomena and then use the knowledge in clinical contexts by deriving therapeutic ideas.

It might be argued that the participants with aphasia in the present study had severe language deficits and most of the patients did not produce any comprehensible verbal output. That is why testing the predictions on the semantic match between gesture and clause structure as proposed by the Interface Model was not feasible. However, we did not observe this trace in either healthy young or old adults. Apart from language and apraxia, non-verbal semantic processing capacities might also have an impact on spontaneous gesturing (Hogrefe et al. 2012). It has been shown that non-verbal semantic processing is a predictor for a successful functional communication in aphasic speakers (Fucetola et al., 2006). Although we did not specifically test this factor, we were specific in our patient recruitment to eliminate those patients with conceptual deficits.

Altogether, more experiments need to be conducted to evaluate the relative merits of the two models (the Interface Model and the Lexical Facilitation Model). Furthermore, they should be tested in other aphasia types. Qualitative gesture coding may help to better understand the interplay between the verbal and gestural behavior in the problems of language production.

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APPENDICES

Appendix A. The list of actions used in the study. Participants are free to formulate their sentence using any structure they wish. All sentences can be produced in either the S-framed or V-framed fashion.

1. Tiptoe in front of the tree	جلوی درخت نوک پا راه رفتن *Jeloy-e- derakht noke-pa rah raftan*
2. Crawl into phone booth	به داخل باجه تلفن خزیدن *Be dakhel-e- baje telefon kahazidan*
3. Walk between the poles	بین ستون ها پیاده راه رفتن *Bein-e- sotunha piyade rah raftan*
4. Skip into the phone booth	به داخل باجه تلفن جست و خیز کردن *Be dakhel-e- bajeye telefon jasto-khiz kardan*
5. Skip between the poles	بین ستون ها جست و خیز کردن *Bein-e- sotunha jasto-khiz kardan*
6. Hop around the tree	دور درخت دو پا جهیدن / لی لی کردن *Dor-e- derakht do-pa jahidan/ley-ley kardan*
7. Crawl in front of the tree	مقابل درخت خزیدن *Moghabel-e- derakht khazidan*
8. Jump jack out of the building	از ساختمان پروانه زنان خارج شدن *Az sakhteman parvane-zanan kharej shodan*
9. Hop to the door	به سمت در دو پا جهیدن / لی لی کردن *Be samt-e- dar do-pa jahidan/ley-ley kardan*
10. Run in front of tree	مقابل درخت دویدن *Moghabel-e- derakht davidan*
11. Jump over the bench	از روی نیمکت پریدن *Az rooy-e- nimkat paridan*
12. Step over the bench	روی نیمکت قدم گذاشتن *Rooy-e- nimkat ghadam gozashtan*
13. Crawl under the sign	زیرتابلو خزیدن *Zir-e- tablo khazidan*
14. Hop across the street	با دو پا جهیدن / لی لی کردن از خیابان رد شدن *Ba do-pa jahidan/ley-ley kardan az khiaban rad shodan*
15. Hop out of the building	از ساختمان به بیرون جهیدن / لی لی کردن *Az sakhteman be biroon do-pa jahidan/ley-ley kardan*
16. Jumping jack between the poles	بین ستونها پروانه زدن *Bein-e- sotunha parvane zadan*
17. Skip around the tree	دوردرخت جست و خیز کردن *Dor-e- derakht jasto-khiz kardan*
18. Twirl around the tree	گردان دور درخت چرخیدن *Gardan dor-e- derakht charkhidan*
19. Hop in front of the tree	مقابل درخت دو پا جهیدن / لی لی کردن *Moghabel-e- derakht do-pa jahidan/ley-ley kardan*
20. March in front of the tree	مقابل درخت راه پیمایی کردن *Moghabel-e- derakht rah-peimayi kardan*

Appendix B. The Farsi adaptation of B-WAB test.

نسخه باليني آزمون تشخيصي زبان پريشي فارسي Persian WAB-1

نام:	سن:	جنس: مرد زن	آزمونگر:
تشخیص:	تاریخ سکته:	تاریخ ارزیابی:	گزارش CT/MRI + -

- **گفتار پیوسته: امتیاز محتوایی گفتار**

دستورالعمل: پرسش های زیر و داستان آشیانه پرنده را از بیمار بپرسید. محتوای پرسش ها و داستان را با توجه به طول و پیچیدگی جمله ها و دستورالعمل ها امتیاز بدهید:

	پرسش		امتیاز
۱	اسم شما چیست؟ (امتیاز ۱)	۱	
۲	آدرس منزل شما چیست؟ (امتیاز ۲)	۲	
۳	چرا شما آمدید بیمارستان؟ (امتیاز ۲)	۲	
۴	تصویر آشیانه پرنده را به بیمار نشان دهید و بگویید: این داستان را کامل برای من تعریف کنید؟ (۵ امتیاز)	۵	
۵=توصیف کامل ۴=توصیف ناقص ۳=تضمین عناصر اصلی ۲=تضمین یک سوم داستان ۱=چند واژه ۰=بدون پاسخ			

امتیاز محتوایی (۱۰)

گفتار پیوسته: (روانی گفتار)

روانی گفتار پیوسته بیمار را با توجه به معیارهای زیر ارزیابی کنید و امتیاز بدهید:

۱۰=سرعت ۱۵۰ واژه در دقیقه
۹=سرعت ۱۲۰ واژه در دقیقه
۸=سرعت ۱۰۰ واژه در دقیقه
۷=سرعت ۵۰ تا ۷۰ واژه در دقیقه
۶=سرعت ۳۰ تا ۵۰ واژه در دقیقه
۵=سرعت ۲۰ تا ۳۰ واژه در دقیقه
۴=سرعت ۲۰ تا ۳۰ واژه در دقیقه
۳=سرعت ۱۵ تا ۲۰ واژه در دقیقه
۲=سرعت ۱۰ تا ۱۵ واژه در دقیقه
۱=سرعت ۵ تا ۱۰ واژه در دقیقه
۰=بدون گفتار

امتیاز روانی (۱۰)

- **درک شنیداری پرسش های آری/ نه**

پرسش های زیر را از بیمار بپرسید و برای پاسخ های آری یا نه و یا با علامت غیر کلامی به او امتیاز بدهید.

	پرسش ها	امتیاز			پرسش ها	امتیاز	
۱	اسم شما علی/ مریم است؟	۱	۰	۶	آیا شما پرستار هستید؟	۱	۰
۲	آیا الان روز است؟	۱	۰	۷	آیا یخ گرم است؟	۱	۰
۳	آیا اینجا خانه شماست؟	۱	۰	۸	آیا پاییز قبل از زمستان است؟	۱	۰
۴	آیا چراغ اتاق روشن است؟	۱	۰	۹	آیا هندوانه را با پوست می خورند؟	۱	۰
۵	آیا کاغذ در آتش می سوزد؟	۱	۰	۱۰	آیا اسب از گنجشک بزرگ تر است؟	۱	۰

امتیاز درک شنیداری (۱۰)

- **درک دستورهای پیوسته**

وسایل مورد نیاز: لیوان، قاشق، مداد و سکه

از بیمار بخواهید دستورهای زیر را به ترتیب انجام بدهد و به او امتیاز بدهید.

	پرسش ها	امتیاز
۱	مداد و قاشق را نشان دهید.	۲
۲	چشم هایتان را ببندید و دست هایتان را بالا ببرید.	۲
۳	اول سقف اتاق و بعد در اتاق را نشان دهید.	۲
۴	قاشق را بگذارید توی لیوان و سکه را پشت و رو کنید.	۴

امتیاز دستورها (۱۰)

- **نامیدن**

از بیمار بخواهید موارد زیر را به ترتیبی که به او نشان می دهید نام ببرد.

۱	مداد	۸	بشقاب	۱۵	بینی
۲	فنجان	۹	شانه	۱۶	عینک
۳	قاشق	۱۰	ساعت	۱۷	شمع
۴	کلید	۱۱	ابرو	۱۸	دکمه
۵	لیوان	۱۲	چنگال	۱۹	کبریت
۶	شست	۱۳	مسواک	۲۰	دندان
۷	کتف	۱۴	سکه		

امتیاز نامیدن (۱۰)

- **تکرار کردن**

از بیمار بخواهید واژه های زیر را پس از شما تکرار کند و به او امتیاز بدهید.

	پرسش ها	امتیاز
۱	سیب	۱
۲	کفش	۱
۳	چای داغ	۱
۴	برگ درختان چنار ریخت	۲
۵	مادر بچه خود را بوسید	۲
۶	سپیده روز صبح زود به مدرسه می رود	۳

امتیاز تکرار (۱۰)

محتوای گفتار	۱۰	
روانی گفتار	۱۰	
درک شنیداری	۱۰	
دستورهای پیوسته	۱۰	
نامیدن	۱۰	
تکرار کردن	۱۰	
جمع	÷۶	
	×۱۰	
ضریب شدت بالینی(AQ)		

Appendix C. The Farsi adaptation of Limb Apraxia test.

آزمون زبان پریشی نامیدن فارسی ۲

آزمون ارزیابی حرکتی زبان پریشی

راهنمای اجرای آزمون:

مرحله اول:

انجام دادن هر حرکت را ابتدا از بیمار بخواهید و برای نوع حرکت به او از ۰ تا ۲ امتیاز بدهید و امتیاز تقلید او را در محل تعیین شده بنویسید.

مرحله دوم:

تقلید: پس از پایان اجرای مرحله اول آزمون از بیمار بخواهید هر حرکت را که امتیاز کمتر از ۲ آورده پس از شما دوباره تقلید کند. کیفیت تقلید بیمار را به صورت؛ **بهتر- یکسان و بدتر** مشخص کنید. و برای هر مورد به او امتیاز بدهید.

جمع بندی:

امتیازهای بدست آمده از اجرای مرحله اول را برای هر نوع حرکت به صورت عددی و برای مرحله دوم به صورت (بهتر- یکسان و بدتر) در جدول صفحه ۱۵ محاسبه و سپس شدت اختلال حرکتی برای هر نوع را مشخص کنید.

آزمون زبان پریشی نامیدن فارسی ۳

الف- حرکتهای مفهومی (بوی بد- سر و صدا- هوای سرد- سکوت)

توصیف: هر یک از این مفهوم ها را به من نشان بدهید:

امتیاز **کیفیت تقلید**

۱- به من نشان بدهید: **بوی بد می آید.**

۲- به من نشان بدهید: **سر و صدا زیاد است.**

۳- به من نشان بدهید: شما **خیلی سردتان است.**

٤- به من نشان بدهید: کسی **سکوت بکند.**

جمع امتیازها

آزمون زبان پریشی نامیدن فارسی ٤

ب- حرکتهای مفهومی اشاره با دست **(خداحافظی- سلام نظامی- آمدن- متوقف کردن)**

توصیف: هر یک از این مفهوم ها را به من نشان بدهید:

امتیاز **کیفیت تقلید**

۱- با دست **خداحافظی** کنید.

۲- **سلام نظامی** بدهید.

۳- از من بخواهید **پیش شما بیایم.**

٤- از اتومبیل بخواهید که **توقف** کند.

جمع امتیازها

آزمون زبان پریشی نامیدن فارسی ٥

پ-حرکتهای دهانی و تنفسی: از بیمار بخواهید حرکتهای **(سرفه کردن- خاموش کردن شمع- بو کردن گل- شربت خوردن با نی)** را اجرا کند.

امتیاز **کیفیت تقلید**

تقلید

۱- سرفه کنید.

۲- شمع را خاموش کنید.

۳- گل را بو کنید.

٤- با نی شربت بنوشید.

جمع امتیاز

ت- حرکتهای تقلیدی برای کار با اشیا: تصویر هر حرکت را به او نشان بدهید و از او بخواهید کار کردن با: **مداد- کلید- لیوان- قوری- مسواک- شانه- چکش- پیچ گوشتی)** را نشان بدهد.

امتیاز **کیفیت تقلید**

۱- با **(مداد)** بنویسید.

۲- با **(کلید)** در را باز کنید.

۳- با **(لیوان)** آب بخورید.

٤- با **(قوری)** چای بریزید.

٥- با **(مسواک)** دندانتان را مسواک بزنید.

٦- با **(شانه)** سرتان را شانه کنید.

۷- با **(چکش)** میخ بکوبید.

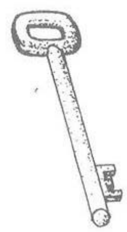
۸- با **(پیچ گوشتی)** پیچ را سفت کنید.

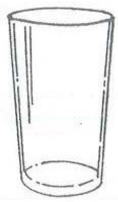
جمع امتیازها

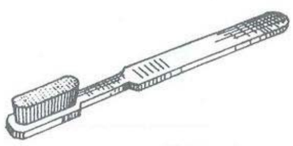
ت- **حرکتهای تقلیدی برای کار با اشیا:** تصویر هر حرکت را به او نشان بدهید و از او بخواهید کار کردن با: **مداد- کلید- لیوان- قوری- مسواک- شانه- چکش- پیچ گوشتی)** را نشان بدهد.

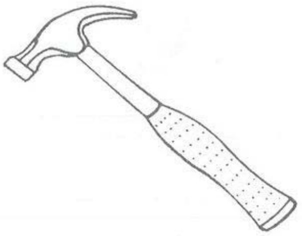
	امتیاز	کیفیت تقلید
۱- با (**مداد**) بنویسید.		
۲- با (**کلید**) در را باز کنید.		
۳- با (**لیوان**) آب بخورید.		
٤- با (**قوری**) چای بریزید.		
٥- با (**مسواک**) دندانتان را مسواک بزنید.		
٦- با (**شانه**) سرتان را شانه کنید.		
۷- با (**چکش**) میخ بکوبید.		
۸- با (**پیچ گوشتی**) پیچ را سفت کنید.		

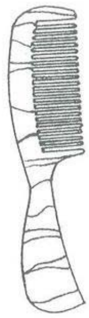
جمع امتیازها [ ]











جمع امتیازها و کیفیت پاسخهای ارزیابی حرکتی

	نوع حرکت اندامها و دستها	تعداد	امتیاز	درصد	تقلید	شدت
۱	حرکتهای مفهومی عمومی					
۲	حرکتهای مفهومی با دست					
۳	حرکتهای تقلیدی برای کار با اشیا					
٤	حرکتهای دهانی و تنفسی					
	جمع کل					

شدت اختلال حرکتی:

- خفیف تا ۷۵٪ امتیاز
- متوسط بین ۵۰٪ تا ۷۵٪ امتیاز
- شدید کمتر از ۵۰٪