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Brain and Language xxx (2006) xxx–xxx

Brain and Language

www.elsevier.com/locate/b&l

Orthographic directionality and thematic role illustration in English and Arabic

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Accepted 2 December 2005

Abstract

This study tested the hypotheses that people had a bias for drawing agents on the left of a picture when given a verb stimulus targeting an active or passive event (e.g., "kicked" or "is kicked) and that orthographic directionality would influence the way events were illustrated. Monolingual English speakers, who read and write left-to-right, and Arabic speakers, who read and write right-to-left, drew agents and patients in response to verb stimuli. We found no significant orthographic directionality effects and no preference for positioning agents on the left of pictures in either group or sentence type. Instead, participants drew agents on the right regardless of language or sentence type, and this was exaggerated in English speakers illustrating passive verbs. These findings support the existence of a preference for placing agents in the right hemispace that may result from asymmetrical hemispheric (i.e., left > right) activation induced by language processing. Our results are consistent with findings that people prefer pictures in which focus is on the right, a preference strongest in pictures with no implicit directionality of movement. This suggests that the methodology of the current study encouraged a static rather than dynamic interpretation of the verb in most participants.
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Keywords: Spatial bias; Arabic; Thematic roles; Sentence illustration; Orthography; Orthographic directionality; Laterality

1. Introduction

Researchers have identified a number of factors that influence performance on tasks pairing pictures and sentences. In sentence–picture matching tasks, the canonicity, or typicality, of the sentence type being produced or comprehended strongly affects accuracy and responses times for healthy and language impaired populations (e.g., Altmann & Kemper, 2006; Blackwell & Bates, 1995; Caplan, Baker, & Dehaut, 1985; Dick et al., 2001). Also, whether the positions of figures in a picture match the positions of nouns in the sentence affects comprehension. For example, people are faster at verifying whether active sentences in English match a particular picture if the figure of the sentence subject is on the left and the figure of the sentence object is on the right (Chatterjee, Southwood, & Basilico, 1999). Similarly, in a language like Arabic which is written right-to-left (R–L), active sentences are verified faster if the picture representing the sentence subject is on the right and that representing the object is on the left (Maass & Russo, 2003). Independent of orthographic directionality, some researchers have suggested that there are universal directional biases for certain elements of pictures to occur on either the left or right of a picture (e.g., Chatterjee, Maher, & Heilman, 1995; Chatterjee et al., 1999; Christman & Pinger, 1997; Levy, 1976). The current study tests several of these factors against each other by looking at the way native speakers of English and Arabic illustrate verbs shown in either citation form (e.g., "kick")

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0093-934X/$ - see front matter. Published by Elsevier Inc.
doi:10.1016/j.bandl.2005.12.003

or passive form (e.g., "is kicked"). To foreshadow our results, several of the factors mentioned above appear to interact to influence sentence illustration.

The directionality of the orthography of a language (i.e., whether a language is read left-to-right or right-to-left) influences the performance of its readers in a number of cognitive domains such as picture appreciation (e.g., Chokron & De Agostini, 2000; Nachshon, 1981), event illustration (e.g., Chatterjee et al., 1995; Maass & Russo, 2003), and performance in a number of linguistic domains (e.g., Hagiwara & Caplan, 1990; Maass & Russo, 2003; MacWhinney & Bates, 1989). The effect of orthographic directionality has often been explored by comparing the performance of speakers of European languages, which are written left-to-right (L–R), to that of speakers of Semitic languages such as Arabic and Hebrew, which are written R–L. English and Arabic are particularly appropriate choices for these comparisons, because the temporal order of words in sentences is similar in both languages. Both English and Arabic are SVO (Subject–Verb–Object) languages (Kaye, 1990). In other words, in most English or Arabic transitive sentences, the first noun phrase, the sentence subject, is assigned the thematic role "agent" (the entity that performs the action of the verb) and the object following the verb is assigned the thematic role "patient" (the entity that is affected by the action of the verb); consequently, in active sentences the movement is typically from the agent toward the patient. In English, this simple active transitive sentence form is so common it is considered the canonical sentence type (Altmann & Kemper, 2006; Ferreira, 1994). In contrast, passive sentences in both English and Arabic position the patient before the verb phrase and the agent following the verb. The most important difference between English and Arabic, for the purposes of the current study, is the directionality of orthography.

Another important factor affecting sentence comprehension is canonical word order; speakers are typically faster and more accurate in sentence production and comprehension tasks when sentences are canonical active sentences (e.g. Altmann & Kemper, 2006; Blackwell & Bates, 1995; Caplan et al., 1985; Dick et al., 2001). Furthermore, this effect is exaggerated when the language system is under stress due to environmental noise or divided attention (Blackwell & Bates, 1995; Dick et al., 2001). The canonical word order of a language also has profound effects on sentence production and comprehension when language is impaired (Bates & Wulfeck, 1989; Nelson, 1976; Saffran & Schwartz, 1994; Schwartz, Marin, & Saffran, 1979; Schwartz, Saffran, & Marin, 1987). A series of studies examining sentence production in a variety of languages found that speakers with aphasia produced disproportionate numbers of sentences using the canonical sentence form specific to their native languages (Bates & Wulfeck, 1989). Similarly, people with language deficits comprehend and repeat sentences with canonical word order much better than sentences with noncanonical word orders, such as passives (e.g. Caplan et al., 1985; Small, Kemper, & Lyons, 2000), and these effects are language specific. For example, Japanese speakers with aphasia showed distinct patterns of comprehension errors compared to English speakers (Hagiwara & Caplan, 1990). Similarly, Hebrew-speaking aphasics with comprehension difficulties who were at chance understanding noncanonical OSV and OVS active sentences, which are syntactically identical to the canonical SVO Hebrew sentence form, were above chance understanding canonical SVO sentences (Friedmann & Shapiro, 2003).

These patterns have been attributed to degradation of the systems that mediate sentence comprehension which leads to greater reliance on a word order based, temporal-spatial strategy than on the presence of grammatical formatives when assigning thematic roles in noncanonical sentences (e.g. Caplan & Hildebrandt, 1988; Grodzinsky, 1990, 1995). In these studies a noun phrase was typically assigned a thematic role based on its relative temporal (in spoken language) or spatial (in written language) position in relation to the verb (Friederici & Gorrell, 1998). Consequently, in English the preverbal noun was assigned the agent role and a post-verbal noun was assigned the patient role, regardless of the syntactic structure of the sentence; for example, when trying to interpret passive sentences (e.g., The cat was chased by the dog), these individuals typically assigned 'cat' the agent role. As a result of this strategy, English-speaking individuals with aphasia typically made few errors understanding canonical active sentences, but had much more difficulty understanding sentences with noncanonical thematic role assignments (Caplan, 1983; Caplan, Hildebrandt, & Waters, 1994).

In contrast to these typical findings on aphasic sentence comprehension, Maher, Chatterjee, Rothi, and Heilman (1995) reported a left-handed, English-speaking man with aphasia due to a right-hemisphere lesion who used a sentence interpretation strategy that was completely based on the spatial characteristics of a picture. When asked to describe a pictured event (e.g., a circle hitting a square), he preferentially assigned the left-most entity in the picture to the subject position of an active sentence, regardless of which entity was actually performing the action. When the examiner attempted to elicit a passive sentence by prompting the individual to use the pictured patient in the subject position, (e.g., "The square..."), the individual often continued the sentence in the active voice, confusing the roles of agent and patient (e.g., "The square hit the circle"), or producing an agrammatic sentence with elements of both sentence types (e.g., "The square is hitting by the circle"). In a sentence comprehension task, this individual also consistently interpreted the left-most figure in a drawing as the agent, regardless of which figure was actually performing the action (Maher et al., 1995). These researchers attributed this pattern of performance to an inability to map thematic roles (e.g., agent and patient) onto grammatical positions (e.g., the sentence subject and object). They argued that a strategy of simply assigning the agent role to the sentence subject to interpret a sentence or picture

(e.g. Hagiwara & Caplan, 1990) could not account for the pattern of performance in this individual, because he answered half of the active sentences wrong: those in which the agent was on the right of the picture. Instead, they argued that this patient used a purely temporal-spatial strategy in which he mapped the first noun he heard or the item on the left of a picture to the subject of an active sentence and the post-verbal noun or the noun on the right of a picture to the object of an active sentence, regardless of the picture being described or comprehended. Based on these results and in contrast to the explanations offered above, this behavior was interpreted as the emergence of a non-linguistic, lower order, directional bias subsequent to the dissolution of the higher-level ability to map thematic roles onto grammatical and conceptual roles. This directional bias was hypothesized to emerge from left hemisphere preferences for L–R movement (Kinsbourne, 1973, 1987) which resulted in a strong bias for interpreting sentence illustrations as if the movement implicit in a picture went from left to right, regardless of the actual directionality in the picture (Chatterjee, 2001; Chatterjee et al., 1995).

Chatterjee et al. (1995) reported supporting evidence for this hypothesis in several subsequent experiments. In the first, when illustrating active and passive sentences, participants showed a propensity to draw the initial noun in the sentence first, and the first figure drawn was most often the leftward figure. Consequently, in active sentences, most participants drew the agents on the left; however, when passive sentences were depicted, this tendency disappeared. In the second experiment, participants drew either the agent or patient of a sentence, which was either active or passive. For active sentence stimuli, agents were drawn further to the left than patients, although once again, this effect was absent for passive sentences. In the third experiment, participants saw either the agent or patient of an action centered on a card with the citation form of a verb above it. Subjects were instructed to draw the missing element (either the agent or patient of the action). Again, agents were drawn closer to the left edge of the paper than patients. To account for these results, Chatterjee et al. (1995) postulated that left hemisphere activation due to the language stimuli induced a bias for L–R directional movement, and that this directional bias influenced the way in which people conceptualized events, independent of the language they spoke. This research, however, only included speakers of English who read and write L–R; therefore, these researchers also allowed that this spatial bias could have been induced by orthographic directionality.

In a further attempt to understand the relationship between language and mental representations of space, Chatterjee et al. (1999) performed a sentence–picture–verification reaction time study using healthy English-speaking subjects in which location of agent and direction of movement (e.g., toward the agent or away from the agent) were separately manipulated. The participants in this study were faster to match an auditory sentence to a picture in which the agent was on the left or in which the action moved from left to right in the picture as encoded by the semantics of the verb (e.g., push vs. pull). These researchers argued that these results were not easily explained by features of the surface structure of language or properties of propositional representations. Instead, they suggested that event concepts have primitive, L–R directional schemas apart from those imposed by orthographic directionality that are based on hemispheric specialization, such that motion concepts underlying linguistic representations (i.e., left hemisphere representations) would induce a preference for L–R implicit motion, which was best accomplished with the agent on the left. Again, this study only included English speakers.

Maass and Russo (2003) tested the relative strength of orthographic directionality and semantic directionality biases proposed in Chatterjee et al. (1999) by comparing Italian and Arabic readers' drawings depicting active sentences with directional actions (e.g., giving and pushing versus receiving and pulling). Due to the word order similarities of Italian and Arabic (which are similar to those described above for English and Arabic), both groups read the same sentence constituents in the same order, and only the orthographic direction that stimuli were printed in differed between groups. The Italian readers performed exactly like English readers in the studies described above (e.g. Chatterjee et al., 1995, 1999) by preferentially drawing figures representing the sentence subjects on the left of their pictures, while Arabic readers tested in their native countries preferentially drew sentence subjects on the right. In contrast, native-speakers of Arabic living in Italy were at chance in their drawing patterns whether they were tested in Arabic or Italian. These findings supported the hypothesis that orthographic directionality affected picture illustration, because when tested in their own countries in their native languages, speakers of Italian and Arabic showed opposite patterns of drawing that were congruent with the directionality of their orthography. In addition, these findings suggested that directional preferences could be altered by continuous exposure to another orthographic system with a conflicting directionality, as in the Arabic speakers tested in Italy. Maass and Russo also found orthographic directionality effects in a task in which participants judged whether an auditory sentence matched a picture. Italians were faster when the sentence subject was pictured on the left, but the Arabic subjects were faster when the sentence subject was pictured on the right. However, both groups were faster when the action of the verb was depicted as moving from L–R. Thus, this research provided support for orthographic directionality effects on picture drawing as well as for an overall preference for L–R directionality of movement as manifested in the semantics of the sentence verb.

Other findings from the sentence illustration literature suggest that additional factors may impact sentence illustration. Jones (1982) asked native English speakers to pro-

duce illustrations of active and passive sentences "to be used with people who don't speak English (p. 238)." This study found no significant preference for drawing the agents of active sentences on either side, but a significant bias for drawing agents on the *right* when illustrating passives. Jones attributed the stronger findings for passives to the marked status of passive sentences which are relatively rare in English. Passive sentences make up between 1 and 35% of sentences produced, depending on the type of discourse (Bates & Devescovi, 1989; Dick & Elman, 2001) and, thus, may be particularly salient to the language user. According to this hypothesis, not only the canonical word order, but also language-specific word orders for particular structures may influence how a sentence is illustrated. However, the findings in Jones (1982) differed considerably from those reported by Chatterjee and colleagues, especially regarding active sentence illustration. Consequently, it appears that factors other than those suggested in these two studies also may influence sentence illustration.

Other cross-linguistic comparisons of sentence illustration cannot explain what these other factors might be. Tversky, Kugelmass, and Winter (1991) asked over a thousand subjects, both children and adults, who were English, Hebrew, or Arabic speakers to illustrate events. They found orthographic directionality effects only in representations of temporal concepts, for which English speakers showed a preference for L–R representation, and Arabic speakers showed a preference for R–L representations. Barrett, Kim, Crucian, and Heilman (2002) compared Korean readers who learned to read R–L to those who learned to read L–R and found no relationship between the direction of reading and the locations of subjects and objects in sentence illustrations.

An area of research unrelated to the linguistic studies above that may help clarify this issue investigates individuals' preferences for pictures compared to their mirror images. Levy (1976), Beaumont (1985), and Chokron and De Agostini (2000) found that people preferred pictures with the item of highest interest, the focus, on the *right* side when pictures had no implicit directionality, regardless of orthographic direction. However, many studies also have revealed preferences for versions of pictures in which the focus appeared to be moving from the left to the right (Braine, 1968; Christman & Pinger, 1997; Freimuth & Wapner, 1979; Levy, 1976). Furthermore, Christman and Pinger (1997) found strongest L–R directionality effects when the focus of the picture was on the left and had an implicit L–R directionality; indeed, directionality effects disappeared when the picture focus was located on the right. While several explanations have been offered for this finding, most have attributed this pattern to an innate bias for L–R implicit movement or focus on the left due to left hemisphere dominance (e.g. Alter, 1989, but see Levy, 1976 for an alternate view). In addition, the directional attention literature has documented strong attentional biases focusing on space contralateral to the hemisphere that is most activated, as well as biases for motion toward the space contralateral to the most activated hemisphere (e.g. Kinsbourne, 1973, 1987; Reuter-Lorenz, Kinsbourne, & Moscovitch, 1990). Language-based tasks enhance left hemisphere activation; consequently, tasks pairing language and pictures might be particularly susceptible to biases for L–R directionality of movement as encoded by verb semantics (Chatterjee et al., 1999: Maass & Russo, 2003) or for more static illustrations with focus to the right (Jones, 1982), if the picture focus is interpreted linguistically to be the agent of the action. The evidence in Maass and Russo (2003) suggests that orthographic directionality also plays a role in this complex scenario.

A serious problem for the picture-preference and attention-direction literature is that most of it has been conducted using speakers of English or other European languages, and, as such, orthographic directionality may play a role by affecting habitual eye gaze patterns, even though picture preference judgment is not a linguistic task (Christman & Pinger, 1997). Levy (1976) documented strong preferences for pictures with the location of focus on the right among English speakers, and predicted L–R directional biases would accompany these. She also predicted that these effects would be orthographic directionality specific, thus foreshadowing much of the literature here. However, only a few subsequent studies have compared directionality preferences in users of languages with differing orthographic directionality. Chokron and De Agostini (2000) found that French speakers preferred L–R directionality of movement in pictures, but Hebrew speakers preferred R–L directionality of movement. Moreover, these preferences strengthened with increasing exposure to orthography: French and Israeli children aged 8.5 years had no significant preferences for either directionality of movement, but the directionality of movement preferences of adults from both language backgrounds was highly related to their orthography. In contrast, all participants in that study showed a preference for landscapes (i.e., pictures with no implicit movement) with focus to the right, and this was strongest in Hebrew-speaking adults. To account for this, Chokron and De Agostini suggested that orthographic directionality was augmenting a universal rightward bias for location of picture focus. These findings contradicted early work on this topic by Braine (1968) who found that early rightward biases in Israeli children changed to leftward biases by about seventh grade, which suggested again that innate and learned factors were influencing responses. The difference in findings between the early Braine study and Chokron and De Agostini was likely due to the latter study explicitly teasing apart direction of movement and location of focus, which were confounded in much of the early literature. Using a different approach, Nachshon (1981) asked English, Hebrew, and Arabic individuals to memorize lists of letters, numbers and shapes, and recorded the order in which they reproduced the lists. All participants tended to recall non-linguistic symbols from left to right, and to reproduce sequences of English letters from left to right, but reproduced Arabic and Hebrew letters

from right to left. However, in all cases, English speakers showed the strongest tendency to start from the left, and Arabic speakers showed the strongest tendency to start from the right, while Hebrew speakers performed midway between the two. Nachshon attributed these patterns to orthographic directionality of English and Arabic, and the mixed pattern taught to Hebrew-speaking Israelis who write Hebrew from right to left, but, in contrast to Arabs, use the western number system and read music L–R. These findings support the hypothesis that there are certain innate directional cognitive biases (e.g., memorizing a list from left to right), but also suggest that these may be augmented or weakened by exposure to congruent or conflicting orthographic directionalities. This literature may contribute to our understanding of the sentence illustration literature, because it suggests that there is a dissociation between scenes in which there is no implicit movement and those with implicit movement: People prefer pictures with no movement to have focus on the right, but pictures with implicit movement may show varying patterns when L–R directionality of movement biases conflict with orthographic directionality.

In summary, the literature suggests that at least three factors compete to influence how sentences or actions are illustrated cross-linguistically: (1) orthography-specific preferences for agent placement (Chokron & De Agostini, 2000; Maass & Russo, 2003), (2) preferences for (drawing) pictures with focus on the left that have implicit L–R directionality due to verb semantics or picture arrangement (Chatterjee, Maher, Rothi, & Heilman, 1995; Chatterjee et al., 1999; Christman & Pinger, 1997; Maass & Russo, 2003), and (3) preferences for pictures with the focus on the right when no movement is involved (Chokron & De Agostini, 2000; Levy, 1976). What is not understood is how or if these factors interact in complex tasks such as sentence illustration.

There are a number of reasons why the various findings described above are not definitive. First, sentence illustration requires both linguistic (and hence, left hemisphere) activation as well as pictorial (i.e., right hemisphere) activation, and as such, may differ considerably from purely visual tasks like picture preference. Moreover, as mentioned above, the attention directionality literature has, for the most part, ignored possible effects of orthographic directionality. However, even within the sentence illustration literature there are a number of methodological issues that make it difficult to fully compare the studies described above. For example, the number of verbs illustrated was very small in many of these studies. Maass and Russo (2003) and Barrett et al. (2002) only asked participants to illustrate four verbs. In addition, two of the four verbs in Maass and Russo were not simple agent-patient transitive verbs. When using the verbs "give" and "receive," the comparisons were between an agent and a recipient and a recipient and a source, respectively. Consequently, results from these verbs may differ from those specifying agent and patient positions. Chatterjee et al. (1995) examined the directionality inherent in active and passive sentences in English by asking participants to illustrate twelve verbs in Experiment 1, but half of these were presented in passive sentences, and the use of verbs in passive or active sentences was not counterbalanced across subjects. Subsequently, in Experiment 2 participants were given all 12 verbs in both the active and passive, but only drew one of the participants rather than the entire event. Consequently, in that experiment determining the left–right relationship of agents and patients required comparing unrelated trials, instead of directly examining the positions of agents and patients in the same trials. Finally, Chatterjee et al. (1999) advocates examining the directionality biases of only those subjects who show "consistent" patterns of drawing agents and patients, thus, eliminating 63% of the participants from his first experiment. Although the majority of subjects were inconsistent in their drawings, their data may have provided a more complete and balanced examination of these questions. For example, if drawings were inconsistent, were agents drawn on the left more often than patients? Or, if agents were sometimes on the left and patients were sometimes on the left, were agents further left than patients? Were the answers to these questions affected by verb type (i.e., active or passive), or by the orthography of the illustrator?

The above questions were addressed in the current study which contrasted the performance of monolingual, native-speakers of Arabic and native-speakers of English when they illustrated the actions of active and passive transitive verbs. We analyzed responses to a relatively large number of verbs (e.g., $N = 18$) which were presented in both active and passive forms in the two languages. In an attempt to minimize specific effects associated with the temporal ordering of nouns (Chatterjee et al., 1995) and to test only event representation, just the verb was presented to subjects for illustration. This method allowed us to explicitly test the relative strength of orthographic directionality against the biases for location of focus on the right (Chokron & De Agostini, 2000; Levy, 1976) versus location of agent on the left with implicit motion to the right (Chatterjee et al., 1995, 1999; Maass & Russo, 2003). To address these questions we compared the spatial representation of thematic roles (i.e., agent and patient) across verb type (i.e., active or passive) and language (i.e., English and Arabic). If orthographic directionality is the most potent factor here, English participants should draw active sentences with agents on the left, and Arabic participants should draw active sentences with agents on the right. If there is a universal bias to draw agents on the left, then both groups of participants should show this tendency regardless of language background. If there is an innate preference for pictures with the item of interest on the right, then both groups should draw agents or subjects on the right. Finally, the use of a strategy based on language-specific word orders may interact with orthographic directionality, causing the relative positions of agents and patients to vary by verb

type (i.e., active vs. passive) and language. Unfortunately, the current study does not allow the comparison of semantic directionality, that is, whether the motion of the verb is toward the agent (e.g., "pull") or away from the agent (e.g., "push") which has been addressed in some of the other papers described above (Chatterjee et al., 1999; Maass & Russo, 2003), because the majority of verbs used in the study (i.e., 15 of the 18[1]) have implicit motion from the agent to the patient.

2. Methods

2.1. Participants

Two groups of participants were included in this study, Arabic-speaking ($N = 20$) and English-speaking ($N = 22$). All subjects were male because of the difficulty in recruiting women who matched on all the demographic variables. All participants were between the age of 40 and 75 years (Arabic $M = 46.45$, $SD = 6.12$; English: $M = 50$, $SD = 6.14$; see Table 1 for the demographic data).

English-speaking participants were volunteers recruited from personnel who worked at the British Aerospace Headquarters office in Riyadh, Saudi Arabia. Arabic-speaking subjects were recruited from Riyadh, Saudi Arabia, through public announcements and through personal communication. All subjects were right handed, as assessed by the Bryden (1977) handedness scale, monolingual and had at least a complete high school education. All subjects signed the informed consent form that was approved by the University of Florida Health Center Institutional Review Board. Items in the informed consent were explained in Arabic to the Arabic-speaking participants and in English to English-speaking participants by the second author, a fluent speaker of Arabic and English.

Potential subjects with impairments in hearing, vision, speech, language, voice, reading, or writing, or with a history of any type of neurological dysfunction were excluded. In addition, all potential subjects were excluded if they performed abnormally on the following tests: (1) Mini-Mental Status Examination, MMSE (Folstein, Folstein, & McHugh, 1975), (Arabic speakers completed an Arabic translation of this test), and (2) a version of the Boston Naming Test, BNT (Kaplan, Goodglass, & Weintraub, 1983) in which culturally inappropriate items for the Middle East (e.g., wreath, beaver) were removed.

2.2. Stimuli

Since the surface structure of canonical, simple active sentences might produce a spatial bias (e.g. Hagiwara & Caplan, 1990; Chatterjee et al., 1999), we presented the subjects only with isolated transitive verbs. Eighteen action verbs (see Table 2) were used in this study and each was presented twice to each subject in his native language; once in an active base form (e.g., chase), and once in a passive form (e.g., is chased). All verbs were imageable and reversible (i.e., when paired with two animate nouns, either was a plausible agent). The order of presentation of these verbs was randomized for each participant.

Table 1
Demographics of the two groups in the study [mean (*SD*)]

	Age	Education	MMSE	BNT
Arabic group	46.5 (6.1)	16.1 (3.04)	29.6 (0.68)	87.6 ± 4.08
British group	50.1 (6.1)	16.4 (3.25)	29.7 (0.48)	96.1 ± 3.35

Table 2
Verb stimuli used in the experiment

English		Arabic	
Active verb	Passive verb	Active verb	Passive verb
Chase	is chased	/ʈa.ra.da/	/ʈu.ri.da/
Kick	is kicked	/ra.fa.sa/	/ru.fi.sa/
Follow	is followed	/ta.bi.ʕa/	/tu.bi.ʕa/
Hug	is hugged	/ʕa:.na.qa/	/ʕu:.ni.qa/
Slap	is slapped	/ʂa.fa.ʕa/	/ʂu.fi.ʕa/
Tap	is tapped	/rab.ba.ta/	/rub.bi.ta/
Push	is pushed	/da.fa.ʕa/	/du.fi.ʕa/
Tie	is tied	/ra.ba.ʈa/	/ru.bi.ʈa/
Crown	is crowned	/taw.wa.ʒa/	/tuw.wi.ʒa/
Splash	is splashed	/raʃ.ʃa.ʃa/	/ruʃ.ʃi.ʃa/
Kiss	is kissed	/qab.ba.la/	/qub.bi.la/
Spray	is sprayed	/raʃ.ʃa/	/ruʃ.ʃa/
Pay	is paid	/da.fa.ʕa/	/du.fi.ʕa/
Carry	is carried	/ħa.ma.la/	/ħu.mi.la/
Stab	is stabbed	/ʈa.ʕa.na/	/ʈu.ʕi.na/
Punch	is punch	/la.ka.ma/	/lu.ki.ma/
Touch	is touched	/la.ma.sa/	/lu.mi.sa/
Scratch	is scratched	/χa.da.ʃa/	/χu.di.ʃa/

Note that all active verbs were presented in their citation forms.

2.3. Procedures

Each trial consisted of the simultaneous presentation of a card with a verb printed on it and a single stick figure line drawing on an 8.5 in. × 11 in. (21.6 × 27.9 cm) sheet of white paper. The stick figure was the same for all verbs and represented a person not performing any action, centered on the horizontal axis of the paper. The verb was presented below the stick figure. The center of the verb, stick figure and paper were all aligned with the participant's midsagittal plane. Participants were given the following instructions:

> "I am going to show you a stick figure of a person together with a verb. When you indicate you understand the verb presented to you, I will withdraw both the verb and the stick figure. On a blank piece of paper, you will be asked to draw two stick figures showing the action of the verb you just saw".

[1] The verbs "tie," "carry" and "crown" seem to have somewhat ambiguous directionality.

Immediately after the paper with the stick figure and the verb card were removed, the experimenter placed a 8.5 in. × 11 in. blank white paper horizontally in front of the participant, so that his midsagittal plane bisected the middle of the paper. After the participant completed drawing the two stick figures performing the action, the participants were asked to indicate the roles of agent and patient by responding to the following question, "Who did what to whom?" After the participant indicated the agent and patient, the investigator marked the paper indicating the thematic role of each figure.

2.4. Measurements and analyses

Following Barrett et al. (2002), we examined two types of dependent variables: (1) the relative frequency of responses in which participants drew the agents to the left of patients, and (2) the distance in centimeters from the left edge of the paper to the center of the torso of the stick figures representing each agent and patient. In the first set of analyses, participants' biases for drawing agents left of patients were compared, first looking at the entire group, then by dividing responses by verb type and language spoken. This analysis was also computed using only the 15 verbs with implicit directionality of movement from the agent toward the patient. In the second analysis, the distance of each figure from the left edge of the response paper was analyzed using a three-way ANOVA, comparing language spoken (English or Arabic), verb form (active or passive), and thematic role measured (agent or patient). Note that, in contrast to Chatterjee et al. (1999), only data from participants who produced agents on both the left and right with both types of verb were included in the latter analysis, based on our contention that a within-subjects comparison is necessary to determine if agents are systematically drawn more leftward than patients are. This eliminated 3–4 participants in each group from this analysis. However, to be consistent with earlier work, the responses of participants who responded consistently in one or more condition were discussed separately.

3. Results

The first analysis investigated whether there was a systematic bias for drawing agents to the left of patients, first in general, then taking into account sentence type and language spoken; this analysis was followed by a regression analysis investigating how consistent participants were in their biases between active and passive sentences. The dependent variable in these analyses was the bias score, the difference in the proportion of times an agent was drawn to the left compared to the right (i.e., % Agents on left − % Agents on right). Note that this score equals zero when people have no directional bias, is positive when people have a bias for drawing the agent on the left, and is negative if people have a bias for drawing the agent on the right. The first analysis combined the bias scores across all subjects and all sentence types, and compared bias scores to zero to determine if there was an overall bias for drawing agents on the left. This analysis revealed a significant bias for drawing the agent on the right ($M = -26.29$, $t(40) = -2.681$, $p < .02$). This supported previous findings that participants had preferences for pictures with focus on the right regardless of language (Chokron & De Agostini, 2000). To explore this result in more detail, the bias ratio was calculated separately for each sentence type for each language group, and the ratio in each of these 4 conditions was compared to zero using one-sample t tests. Arabic speakers showed no directional bias in agent placement ($M_{Act} = -22.22$, $M_{Pas} = -20.00$; both $p > .20$). English speakers showed a non-significant bias for drawing agents on the right when illustrating active verbs ($M = -24.87$; $t(20) = 1.77$, $p < .09$), and they had a significant bias for drawing the agent on the right when illustrating passive verbs ($M = -37.57$; $t(20) = 3.13$, $p < .01$). Subsequently, we compared the leftward biases of the two groups on the two verb types using a (2) Sentence Type by (2) Language Group ANOVA. There were no significant effects, showing that, overall, neither the language spoken nor the verb type illustrated led to significant differences in the placement of the agent in participants' drawings. These calculations were repeated using only the 15 verbs with implicit directionality of movement, with identical results. Finally, an examination of the distribution of bias scores showed very different patterns across groups; bias scores for active and passive sentences are graphed against each other in Fig. 1. Among Arabic speakers, there was a clear bimodal distribution for both active and passive drawings. When drawing active verbs, 8 subjects showed a clear left bias (bias range 44–100%), and 12 showed a clear right bias (bias score range −66 to −100%). Similarly, when drawing passive verbs, again 8 subjects showed a clear left bias (bias score range 33–88%), and 12 showed a clear right bias (bias score range −33 to −100%). As shown in Fig. 1, there was no bimodal distribution among English-speaking participants, instead these participants showed more graded, probabilistic responses to stimuli. Bias scores of both groups for active and passive sentences were highly correlated ($r_{Arab} = .72$, $r_{Eng} = .82$, both $p < .001$), showing individual directional biases were relatively stable across sentence types.

To analyze differences in the actual distance of agents and patients from the left edge of the page, a (2) Sentence Type by (2) Thematic Role by (2) Language Group ANOVA was calculated. The hypothesis regarding preferential placement of agents to the left of patients (Chatterjee et al., 1999) would predict a main effect of thematic role with agents being more leftward than patients, while the rightward focus hypothesis predicts agents would be drawn more rightward than patients. In contrast, a strategy based on orthographic directionality would predict a two-way interaction between language group and thematic role with English speakers having a bias to put agents on the left and Arabic speakers to put agents on the right. Finally, a strategy of purely

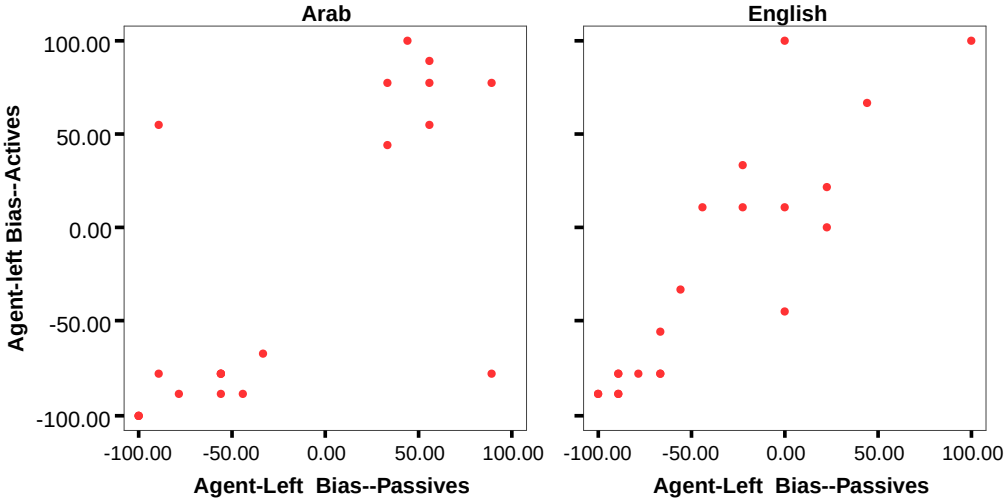

Fig. 1. Bias scores for active versus passive sentences for each group. Note the bimodal distribution among Arab speakers compared to the strong gradient performance of the English speakers.

mapping the temporal–linear form of the sentence using the orthographic directionality and word order of the language would predict a three-way interaction between language group, sentence type and thematic role. As stated above, only participants who drew agents and patients on both the left and the right for both verb types were included in this analysis. This left 17 Arabic and 18 English speakers in the analysis. Mean distances from the left edge of the page are shown in Table 3. The only significant effect in this ANOVA was a main effect of group: English speakers drew their pictures significantly to the left of where Arabic speakers drew their pictures ($M_{\text{Eng}} = 12.55$ cm, $M_{\text{Arab}} = 15.45$ cm; $F(1,31) = 14.94$, $p < .001$, $\eta^2 = .33$). This finding likely reflects a learned motor bias governing where the hand is initially placed on the paper.

Finally, following Chatterjee et al. (1999) and Barrett et al. (2002) the drawing biases of those participants who consistently drew agents and patients in similar locations in all their drawings were examined. Only one British participant drew all pictures with both verb types with the agent on the left, and three Arabic speakers drew all of their responses regardless of verb type with agents on the right, thus providing some evidence for strategies based on orthographic directionality in some subjects. However, one British and one Arabic speaker positioned agents leftward for all actives, but were at chance with passives as found in Chatterjee et al. (1995), and two British participants illustrated all passive verbs with agents on the right and most of the illustrations for actives with agents on the right also (i.e., bias scores for both = −89), showing a strong preference for pictures with rightward focus. These findings argue strongly for individual differences in the strengths of innate and learned biases for verb illustration.

Table 3
Mean centimeters figures were drawn from the left edge of the paper for participants who were inconsistent in the positions in which they drew agents and patients

	Agents		Patients	
	Mean (cm)	(*SD*)	Mean (cm)	*SD*
Arabic ($N = 17$)				
Active verbs	15.60	(3.87)	14.89	(3.63)
Passive verbs	15.81	(3.07)	14.91	(3.81)
British ($N = 18$)				
Active verbs	13.32	(1.92)	12.01	(2.48)
Passive verbs	13.66	(1.88)	11.82	(2.49)

4. Discussion

This study tested whether participants would show a bias for drawing agents on the left side of a picture when given a verb stimulus that required the reader to conceptualize an active or passive event (e.g., "kick" or "is kicked"). In addition, to test the hypothesis that orthographic directionality would influence the way events were illustrated, we compared monolingual participants from two different orthographic backgrounds, English speakers who read L–R and Arabic speakers who read R–L. We found no significant orthographic directionality effects and no preference for positioning agents on the left side of pictures in either group or sentence type. Instead, participants showed a significant overall preference for drawing agents on the right regardless of language or sentence type. In addition, English speakers showed a significant bias for drawing agents on the right when illustrating passive verbs, but their rightward bias for the positions of agents when illustrating active verbs did not reach significance. Moreover, there was no tendency in either group to place agents further to either side when looking at position relative to the paper edge, and even participants who consistently drew agents and patients in the same relative positions showed no consistent preference for placing agents on the left of a picture. Nevertheless, participants were remarkably consistent in their directional biases (i.e., the percent of agents left less

percent of patients left) across verb types, although the two language groups showed very different distributions of bias scores, as discussed below.

These findings support the presence of a right hemispatial, viewer-centered bias for drawing isolated representations. This right spatial bias might be induced by asymmetrical (i.e., L > R) hemispheric activation, induced by language processing. This finding is also consistent with research in the picture preference literature in which English speakers preferred pictures with focus on the right (Banich, Heller, & Levy, 1989; Christman & Pinger, 1997; Levy, 1976). This preference was also strongest when there was no implicit directionality of movement in the picture (Chokron & De Agostini, 2000; Christman & Pinger, 1997), suggesting that the methodology of the current study encouraged a static rather than dynamic interpretation of the verb in the majority of participants. Nevertheless, there was considerable individual variation in bias strength among individuals of both groups.

The results of the current study are also consistent with those of Barrett et al. (2002) who found no tendency for Korean L–R readers to draw agents on the left. In addition, Barrett found similar distributions of bias scores among her L–R and R–L readers as those reported here: L–R readers showed a more continuous, graded bias distribution for agent placement with several participants at chance; whereas, R–L readers in both studies were more "lateralized," choosing either to put most agents on the left *or* on the right, with very few, if any, participants at chance. Arabic speakers, the R–L readers in the current study, performed similarly. Eighteen of 20 individual participants showed strong, consistent preferences for either leftward or rightward agents. One possible explanation is that individuals' perception of the task varied as to whether they were illustrating static scenes (and thus positioned the agent/focus on the right nearly all the time) or dynamic events with implicit motion (and thus positioned agent/focus leftward nearly all the time). If this were so, this effect was relatively unmitigated in Arabic participants (and Barrett's R–L Korean readers), leading to stronger biases in one direction or the other. In contrast, using a L–R orthography, the English speakers here or Barrett's L–R Korean readers, apparently acted as a mitigating factor that led to more random performance.

The results for the English speakers in the current study were nearly identical to those reported for English speakers in Jones (1982) who also found no directional bias for drawing agents in active sentences, but a significant bias for drawing patients on the left and agents on the right when illustrating passives. Interestingly, in Chatterjee et al. (1995) illustrating passive sentences also led to a decreased preference for agents on the left, leading to no significant bias for passives in that study. Thus, in all three of these studies illustrating passive sentences or verbs diminished the tendency to draw agents on the left likely as a result of the effects of the marked word order of passives (Jones, 1982), augmenting preferences for picture focus on the right. The lack of the expected reverse effect for active sentences (i.e., agents drawn on the left) is puzzling, but is consistent with other findings in the linguistic literature of minimal effects associated with unmarked structures (Battistella, 1990).

The results of the current study differed considerably from those in Chatterjee et al. (1995).[2] Participants in that study showed stronger leftward biases for agents than the English-speaking subjects did in the current study. Their participants drew both the agent and patient for active and passive sentence stimuli in Experiment 1 in response to auditory stimuli. We suspect that the usage of full sentence stimuli increased the likelihood of participants focusing on the implicit motion inherent in the sentences, thus activating biases for L–R implicit directionality of motion, and these effects combined with orthographic directionality effects to exaggerate preferences for agents on the left. Maass and Russo (2003) also found significant effects of orthographic directionality when illustrating active sentences but with written sentence stimuli in Italian and Arabic speakers. These researchers attributed their findings to orthographic directionality, although there may have also been a strong spatial bias due to orthographic presentation of full sentence stimuli on the same page as the drawing.

The lack of strong L–R or orthographic directionality effects on event depiction in the current study and in Jones (1982) was somewhat surprising considering the robust effects of picture composition on sentence production and picture preference. Bock (1986) noted that English speakers produced more active sentences when describing pictures in which the agent was on the left of a picture than when the agent was on the right, and more passives when the patient was on the left. Similarly, Hartsuiker and Kolk (1998) reported that speakers of Dutch, another language with L–R orthography, produced more active sentences when the agent was on the left side of a picture than when it was on the right. These studies demonstrated that spatial characteristics of an illustration influenced the choice of the structure of the sentence used to describe it; however, to our knowledge, no one has investigated picture description in readers of R–L languages. As described above, orthographic directionality influences people's preferences for the spatial composition of pictures: speakers of European languages preferred pictures with L–R directionality (Chokron & De Agostini, 2000; Christman & Pinger, 1997; Nachshon, 1981), but speakers of Hebrew and Arabic preferred pictures with R–L directionality

[2] One possible explanation for this would be that one aspect of our methods, asking participants "who did what to whom?" may have influenced their responses. However, if this had any effect, this repeated emphasis on the active sentence structure would most likely have strengthened the tendency to put agents on the left, or reinforced the effects of orthographic directionality. Thus, we believe the effects of this question on the positions of agents and patients in verb illustrations were minimal.

(Chokron & De Agostini, 2000; Nachshon, 1981). Based on this, one might predict that the picture descriptions of R–L readers might begin on the right, because learning to read leads to strong habitual gaze patterns that follow the directionality of the orthography (Levy, 1976). However, there is also the possibility that the linguistic demands of such a task would increase left hemisphere activation and augment the attentional bias for movement from L–R, resulting in picture descriptions beginning on the left. This is an empirical question that would best be investigated by eye-tracking studies investigating the picture descriptions, sentence–picture matching, and picture preferences of readers of orthographies with differing directionality.

To account for the results presented here and elsewhere in the literature, we suggest that several competing factors contribute to how a sentence or event is illustrated. First, people tend to draw pictures with focus (i.e., item of highest interest) on the right, particularly when a scene has no implicit movement. Second, when there is implicit movement or directionality in what is being illustrated, people tend to illustrate the movement as progressing from left to right. Furthermore, we hypothesize that these factors compete when people illustrate sentences, such that the former factor is stronger if the sentence is construed as having no implicit movement, but the latter factor is stronger if the sentence is construed as involving movement (e.g., the agent in motion toward the patient). The results here also suggest that the relative strength of these factors varies between individuals within a language group. Finally, orthographic directionality and language-specific word orders may augment or diminish the relative strength of these biases depending on details of the experimental paradigm.

Acknowledgments

This work was supported in part by VA Office of Research and Development, Rehabilitation R&D Service, Brain Rehabilitation Research Center and by NIDCD/NIH Grant P50 DCO3888.

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