

Stroke Direction Asymmetry in Figure Drawing: Influence of Handedness and Reading/Writing Habits

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Recent studies suggest that asymmetries noted in certain nonlinguistic tasks used in laterality research (e.g., facial affect judgment, line bisection) may in part be influenced by prior reading/writing habits. The present study examined the relative influence of reading/writing direction and handedness on the direction of stroke movement in free-hand figure drawing. One hundred twenty right and left handed brain-intact adult readers of scripts with opposing directionality (Hindi vs Urdu) and illiterate controls were observed while drawing a tree, a hand, a house, an arrow, a pencil, and a fish. Right-handers (including right-handed illiterates) and left-to-right readers drew most figures in a left-to-right direction, whereas left handers (including left handed illiterates) and right-to-left readers more often drew the figures from right to left. These results extend previous findings and contribute to a growing body of evidence demonstrating reading scan biases in nonlinguistic perception and production tasks. It would appear that

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reading/writing habits cannot be ignored as a potential artifact in studies of hemisphere functional asymmetry employing nonlinguistic stimuli. © 2002 Elsevier Science (USA)

INTRODUCTION

Some languages are written and read from top to bottom, others from left to right, and still others from right to left. Exposure to a particular writing system influences the order of recall of visually presented linear arrays of stimuli (see Nachshon, 1985, for a review of studies with Hebrew or Arabic readers). Interestingly, reading/writing biases are not restricted to recall effects or found only for linguistic stimuli, but rather "invade" perception or production of nonlinguistic stimuli as well. The presence of such biases has been noted for tasks as varied as aesthetic perception (Chokron & de Agostini, 2000; Nachshon, Argaman, & Luria, 1999), line length estimation (Singh, Vaid, & Sakhuja, 2000), chimeric facial affect judgment (Eviatar, 1997; Sakhuja, Gupta, Singh, & Vaid, 1996; Vaid, 1995), speeded linear dot production (Vaid, 1998), the perception of apparent motion (Morikawa & McBeath, 1992), naming and recall of linearly arrayed pictured objects (Padakannaya, Devi, Zaveria, Chengappa, & Vaid, *in press*), and covert spatial attention (Eviatar, 1995).

The present research considered the potential influence of reading/writing habits and handedness-linked movement biases on the direction of stroke movement in drawing simple objects, such as an arrow or a flag. It has been noted in other tasks that hand movements directed away from the body are performed more easily than those directed toward the body (van Sommers, 1984; see also Vaid, 1998). In the task of figure drawing, then, one would expect stroke direction asymmetries to vary as a function of the hand used to draw, with drawings executed with the right hand proceeding more easily in a left-to-right direction whereas those done with the left hand proceeding more easily in a right-to-left direction. Whether this hand movement bias might interact with reading/writing habit-induced biases in stroke direction was of additional interest.

In previous related research (Vaid, 1995) we examined the direction in which line drawings of directional objects were oriented by readers of scripts with opposing directionality. Participants were readers of Hindi (a language that is read and written from left to right) and Urdu (a language that is read and written from right to left). From a methodological perspective what is particularly compelling about this language pair is that, on the spoken level, Hindi and Urdu are virtually identical. They differ primarily on the written level: Hindi uses the Devanagari script, a writing system originally developed for Sanskrit, while Urdu uses a Perso-Arabic script. In two previous studies, we examined right-handed adult readers of Hindi and Urdu and Arabic (Vaid, 1995, Study 1) and right- vs left-handed Hindi and Urdu children (Vaid, 1995, Study 2) on a figure drawing task. The results showed that, among right handers, objects tended to be drawn facing left by Hindi readers while Urdu and Arabic readers tended to orient the same objects facing right. Among left-handers, however, the majority of items by Hindi and Urdu readers alike were drawn facing left. These results were taken as support for an influence of reading/writing habit on drawing orientation, but one that was limited to right handers, given that left handers appeared to be more influenced by a hand movement asymmetry favoring extensional movements.

While the present study also compared Hindi and Urdu readers on a figure drawing task, the dependent measure of interest was stroke movement direction, rather than object facing. Moreover, whereas in previous work (e.g., Vaid, 1995) handedness effects had been examined in a child sample, in the present study an adult sample

of right vs left handed Hindi and Urdu readers was tested. In addition, the present study tested a sample of (right vs left-handed) illiterate speakers of Hindi/Urdu. Inclusion of the illiterate subgroups should provide an additional way of teasing apart the relative influence of reading/writing habits from handedness effects.

RATIONALE

If figure drawing is uninfluenced by biomechanical or reading/writing habits, then the percent of drawings executed in a leftward direction should be about equal to those executed in a rightward direction. If figure drawing is influenced primarily by biomechanical factors, specifically, innate directional tendencies in muscular movement such that movements directed away from the body are executed more smoothly than those directed toward the body, one would expect more drawings with the right hand to have a left-to-right stroke direction and more drawings with the left hand to have a right-to-left stroke direction, in all three linguistic groups. If, however, movement asymmetries in figure drawing primarily reflect reading/writing habits, then one would expect that, regardless of handedness, readers of Hindi would show a left-to-right movement preference in figure drawing while readers of Urdu would show a leftward movement bias; illiterates would show no consistent directional preference.

Whereas both the biomechanical and the reading/writing habit explanations would predict a left-to-right directional preference in right handed Hindi readers and a right-to-left directional preference in left handed Urdu readers, the two variables make opposite predictions for right handed Urdu and left handed Hindi readers. Thus, the outcome of these latter subgroups (together with that of the illiterate right vs left handers) will be of particular interest in determining the relative strength of the biomechanical versus reading/writing habit explanation.

METHOD

Participants

Subjects were 120 brain-intact subjects between 15 and 20 years of age residing in New Delhi. They were subdivided into three groups in terms of language experience: 40 were native readers of Hindi (a language read and written from left to right), 40 were native readers of Urdu (a language read and written from right to left) and 40 were illiterate age-matched controls speakers of Hindi/Urdu. The Hindi readers (Group 1) were enrolled in an English medium of instruction school. The Urdu readers (Group 2) were enrolled in an Urdu medium of instruction and the illiterates (Group 3) had no formal schooling. Each group was further subdivided by handedness and sex, with 10 subjects per cell. Handedness was assessed by subjects' stated preference on the Annett (1970) inventory and by their observed performance on the inventory items. Only strongly right- or left-handed subjects (defined as those who reported a preference and showed a performance favoring a particular hand for 75% of the activities) were included.

Materials and Procedure

Subjects were tested individually in a quiet laboratory setting with the experimenter seated next to the subject on either the left or the right side, randomly. They were given a response sheet with six marked spaces each containing the name of an item at the top center and were instructed simply to produce a quick sketch of each of the items in the space provided, using their preferred hand. The figures to be drawn

TABLE 1
 Right-Handers' Frequency of Figures Drawn
 from Left-to-Right vs from Right-to-Left as a
 Function of Reading/Writing Habit ($n = 20$ per
 Language Group)

	Illiterate	Hindi	Urdu
Left-to-right	79	85	33
Right-to-left	21	15	67

were a tree, a hand, a house, an arrow, a pencil, and a fish and subjects were told they could draw the figures in any order. For each figure, with the exception of the tree (included as a filler item), the predominant stroke direction employed—right-to-left or left-to-right—was noted.

RESULTS

Per subject, the total number of figures drawn in a leftward vs rightward direction was entered into a series of chi square analyses. (A correction for continuity was computed for all chi square analyses involving a single degree of freedom.) An initial analysis revealed no significant sex difference in direction of movement [$\chi^2 = 2.19$, $df = 1$, $p = .14$]; males drew 47% and females drew 40.7% of the figures toward the right side. A chi square comparing right and left handers was highly significant [$\chi^2 = 111.6$, $df = 1$, $p < .0001$]; left handers drew a majority of the figures to the left side (78%) while right handers drew a majority to the right (66%). The chi square analysis by Language group (Hindi readers, Urdu readers, and Illiterates) was also significant [$\chi^2 = 28.53$, $df = 2$, $p < .01$]; while Hindi readers and illiterates showed no particular directional bias, Urdu readers drew the majority of the drawings toward the left side (71%), in accordance with their right-to-left reading/writing habit.

The data per Language group were analyzed by Handedness in three separate chi square analyses. The results showed a significant effect of Handedness in the Illiterate sample [$\chi^2 = 74.54$, $df = 1$, $p < .0001$] and in the Hindi sample [$\chi^2 = 72.59$, $df = 1$, $p < .0001$] but no effect of Handedness in the Urdu sample [$\chi^2 = 1.19$, $df = 1$, $p = .27$]. For both the Illiterate and Hindi samples, right handers showed a predominant left-to-right stroke movement while left handers showed a right-to-left movement. For the Urdu sample, both right and left handers showed a right-to-left stroke movement bias.

Finally, two additional chi square analyses were performed, comparing the values per Handedness group by Language group. For right-handers (see Table 1), there was a significant effect of Language group [$\chi^2 = 71.85$, $df = 2$, $p < .0001$] indicating

TABLE 2
 Left-Handers' Frequency of Figures Drawn
 from Left-to-Right vs from Right-to-Left as a
 Function of Reading/Writing Habit ($n = 20$ per
 Language Group)

	Illiterate	Hindi	Urdu
Left-to-right	17	24	25
Right-to-left	83	76	75

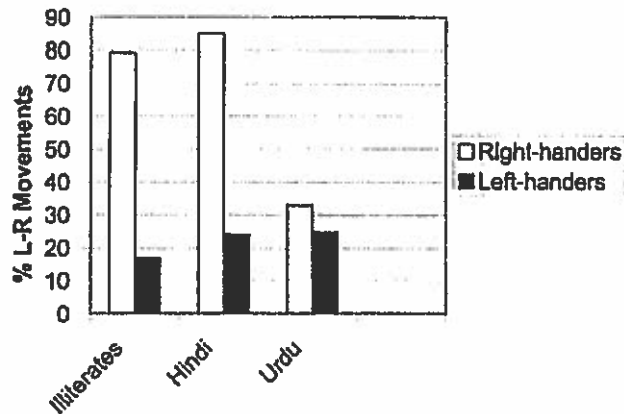


FIG. 1. Incidence of left-to-right movement bias in stroke production as a function of reading habit.

that a propensity to draw figures toward the right side characterized the Hindi readers (who drew 85% of the drawings in a rightward direction) and the illiterate right handers (79% rightward), but not the Urdu right handers, who instead showed a right-to-left directional preference (67% leftward).

In the analysis for left-handers (see Table 2), there was no significant effect of Language group [$\chi^2 = 2.21$, $df = 2$, $p = .33$], with all groups showing a right-to-left movement preference (76, 83, and 75%, for Hindi, Illiterate, and Urdu groups, respectively). A summary figure of the results as a whole is presented in Fig. 1.

DISCUSSION

The present findings on stroke direction biases in figure drawing corroborate those summarized in Vaid (1995) on the facing of directional figures and demonstrate that reading/writing habits clearly influence this ostensibly nonlinguistic task. As such, these results add to the growing body of evidence documenting the influence of reading/writing habits on nonlinguistic tasks. However, reading/writing habits were not the sole influence on asymmetries in figure drawing, as the performance of our illiterate sample demonstrated. While this group showed no overall movement bias when considered as a group, their performance clearly differed when the variable of handedness was considered: right handed illiterates showed a left-to-right stroke bias while left handers showed a right-to-left bias. Thus, a biomechanical influence appears to be operative in figure drawing direction when reading/writing habits are not present.

What happens when reading/writing habits predict one outcome and biomechanical principles predict the opposite outcome? Such was the case for left-handed Hindi readers and for right-handed Urdu readers. In the former case, the results favored a biomechanical influence, as left-handed Hindi readers showed a right-to-left bias, contrary to the expectation based on their (left-to-right) reading/writing habits. However, for right-handed Urdu readers, a reading/writing habit effect appeared to be a stronger influence, in that these individuals showed a right-to-left bias, contrary to the left-to-right expectation for extensional movements with the right hand (see Fig. 1). In summary, our results suggest that reading/writing habits do exert a strong influence that can supersede that of biomechanical principles, but only when the writing hand is the right hand. For left-handers, a reading/writing bias was not sufficient to offset biomechanical principles influencing hand movement asymmetries. These outcomes obtained from a large, adult sample corroborate what had previously been reported for a smaller child sample (Vaid, 1995, Study 2).

Tasks involving asymmetries in perception or production are often used in studies of hemispheric specialization of function. Our findings, taken together with those of several other recent demonstrations of cultural influences on laterality (e.g., Chokron & DeAgostini, 2000; Eviatar, 2000) have certain implications. They suggest that explanations invoking hemisphere-specific mechanisms as the favored account of observed asymmetries in verbal or nonverbal performance cannot afford to ignore either hand movement-related directional biases or directional scanning tendencies arising from reading/writing experience as additional sources of influence to be controlled or systematically explored.

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