Age of Acquisition Effects of American Sign Language on Mental Rotation

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Abstract

•This study was designed to examine whether age of acquisition of American Sign Language affects non-linguistic mental rotation abilities

•Comprehension of ASL spatial relations typically requires a 180° mental rotation whereas production requires no rotation of signs.

•In English, no rotation is required for either comprehension or production of spatial relations.

•Participants were 54 adults who acquired ASL at different ages, and 18 adult non-signers.

•Signers, regardless of age of acquisition, were more accurate than non-signers at 180° of rotation.

Introduction

•Age of acquisition effects in both spoken and signed langages are well-documented (e.g. Johnson & Newport, 1989; Emmorey et al., 1995).

•Earlier age of acquisition increases performance on a variety of linguistic tasks such as grammaticality judgements (Emmorey et al., 1995).

•Interest has also surged in documenting the effects of age of acquisition of language on non-linguistic cognitive processes.

•Emmorey (1993) found that deaf adults were faster on a mental rotation task than hearing non-signers at 0, 90, 135 and 180 degrees.

• Deaf adults were not more accurate than hearing non-signers (Emmorey, 1993), but native signers were more accurate than non-native early signers.

•A comparison between native signers and early non-native signers in response time was not reported in Emmorey (1993).

Current Study

•The first goal of the current study is to examine differences between native, early and late signers in mental rotation response time and accuracy.

•The second goal is to determine which aspect of ASL spatial relation knowledge contributes to mental rotation.

Methods

Participants:

• 19 adult native signers (13 deaf, 6 hearing)

•13 adult early signers (mean age of ASL acquisition 4;6; 11 deaf, 2 hearing)

•16 adult late signers (mean age of ASL acquisition 22; 8 deaf, 8 hearing)

•18 adult non-signers

Procedure:

Mental Rotation:

Participants saw 56 trials of two bear figures on a laptop screen and were asked to decide whether the bears were the same or different as quickly and accurately as possible.

•Each bear had one arm raised (see figure 1). Participants judged whether the two bears held the same arm up or each held up a different arm.

•The bear on the right was shown at one of the following degrees of rotation from the upright position: 0 (no rotation), 30, 60, 90. 120. 150 or 180 degrees .

•Participants received 8 trials at each rotation: 4 were "SAME" and 4 were "DIFFERENT"

•Mental rotation was measured as the slope of change in response time across increasing degrees of rotation

Language Measures:

Comprehension: 24 trials of two pictures depicting opposite relations were shown to participants (see figure 2) who sat directly across a table facing the experimenter.

•The experimenter signed a description of one of the pictures in the set and the participant chose which of the two pictures matched the description.

•Production: The procedure was similar to comprehension, but the participants' and experimenter's roles were reversed.

•Participants were given a target picture to sign to the experimenter, who chose which of two pictures matched.

•In both tasks, spatial relations tested were 6 relations involving mental rotation: *in front, behind, right, left, towards, away*, and two not involving mental rotation: *above, below.*

•Participants' comprehension and production responses were recorded as rotated or not rotated

Figure 1: Sample Mental Rotation Stimuli

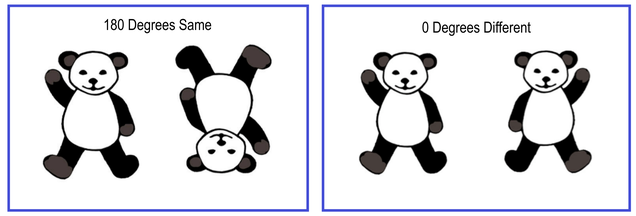
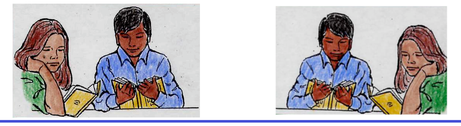


Figure 2: Sample Language Task Stimuli

LEFT: Which of your pictures shows the girl on the left?



Results

MENTAL ROTATION

•Accuracy:
•Overall, an average of 97% of trials were answered correctly by all participants.
•An ANOVA showed a significant difference between groups (F=1.25 (3, 65) p=.05)
•At 180 degrees non-signers performed significantly less accurately than signers (F= 2.83 (3, 63) p < .05) (see figure 3)

•Response time:
•No overall effect of age of acquisition on slope of response times (F=. 378 (3, 62) p=.77), hearing status (t=.931 (64), p=.355) or gender (t= -1.72 (17) (see table 1).

Figure 3: Mean Accuracy for Each AoA group at 180

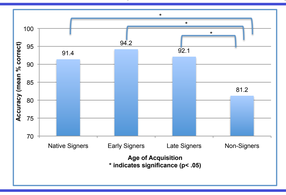


Table 1: Slope of Change in Response Times Across Degrees of Rotation for Each Group

Group	Men	Women
Native Signers	.11	.20
Early Signers	.17	.14
Late Signers	.18	.19
Non-Signers	.16	.17

Table 2: Percent of Rotated Responses on Language Task Items Involving Rotation (*in front, behind, right, left, towards, away)*

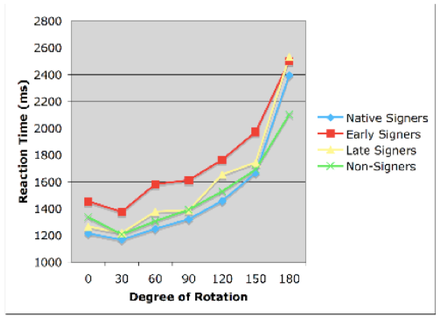
	Comprehension	Production
Native Signers	75%	23%
Early Signers	82%	21%
Late Signers	74%	18%
	(77% rotated: 23% not rotated)	(79% not rotated: 21% rotated)

LANGUAGE MEASURES:

•Comprehension:
•For items not involving rotation (*above, below)* participants chose the matching picture on 100% of the trials.
•For the six items involving rotation the comprehension score reflects the participants' rotating the relative positions of the signs they see
•Participants chose the rotated response (i.e. the correct response) on average about 76% of the trials.
•There were no significant differences of rotated responses among the three signing groups.
•Among native signers, there was a marginally significant trend for men to more consistently rotate than women (p=.08).

•Production:
•As expected, participants rotated on the comprehension task a majority of the time, whereas they rotated on the production task much less frequently (see table 2).
•Note that tendencies in the two tasks correspond: 77% of comprehension trials were rotated, whereas 79% of the production trials were NOT rotated
•There were no differences between age of acquisition groups, men and women and no correlation between rotation on the language tasks and performance on the mental rotation task.

Figure 4: Response time for each group across degrees of rotation



Discussion

•Learning ASL, but not the age of acquisition, appears to improve mental rotation skill for the most difficult rotation only (180°).
•Lack of differences in speed of mental rotation may be due to the relative simplicity of the task. A task with more complex figures may reveal differences in age of acquisition.
•No relation was found between the rotation on the language task and performance on the mental rotation task indicating that effects of ASL may be from general experience provided by the spatial nature of the language or another aspect of language not tested here.
• Future research should address the timing of the effect of improved mental rotation for adult late signers and other sign languages.

References

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