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Which Factors Affect Midline Crossing in Adult: Combined Effect of Task Complexity and Object Location

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Abstract. According to kinesthetic approach, motor system in order to increase mechanical efficiency prefers to response to the target with ipsilateral hand that this phenomena knows as hemispheric bias. However, accomplishing a preferred hand reach for contralateral object needs to cross the body midline that this is an inefficient act and also could be related with some learning disability. Different factors such as age and motor dominant influences the frequency of midline crossing (based on studies on samples of children and infants). So in order to investigate the effect of factor such as skill demand and objects location, the aim of current research was to study factors that affect midline crossing in adult. **Method** : in present semi experimental study,85 strong right handed (age18-25)as determined by annet handedness questionnaire were asked to reach 5 different objects at five different location and perform three different tasks(lift ,pantomime and real use)with objects. On the other hand in present study (ANOVA) was used to analyze the data and alpha level of p<. /05 were used to determine significant. **Result**: 1- with increasing the task difficulty the frequency of preferred hand reaches and midline crossing were increased, so the least frequency of preferred hand reaches were made for lift task. But there was no significant difference between pantomime and actual use tasks. 2- The effect of object location showed that the least preferred hand reaches were made to the far left. **Discussion**: With respect to these findings, it is suggested that environmental factors as well as biological factor and some times more than them influence select of preferred hand and midline crossing.

Keywords: object location, task complexity, midline crossing

1. Introduction:

Human beings are required to use their hands for doing a lot of actions and using different objects (combing, brushing teeth, and writing), and, in order for any object to be used, it must be put in reaching. Therefore, it seems that reaching is an inseparable component of human actions (hand-related actions). However, people often prefer to do a lot of reaching actions and reach most of objects in their surrounding with preferred hand. Based on this we can conclude that repetition and frequency of reaching with preferred hand is much more than reaching with non-preferred hand (9, 14, 16, 24). However, according to some studies, people, at different ages, prefer to use their preferred hand for accessing to the most of objects in environment even objects in contra lateral hemispace that this phenomenon can result in crossing the body midline (4, 5). Based on Kinetic view, carrying out actions of each side of the body with ipsilateral hand is defined as hemisphere bias or kinetic efficiency. Hemisphere bias means that using ipsilateral hand for reaching can restrict the biomechanics constraints' effects on movement, in addition, using contralateral hand in performing such actions requires longer trajectory and midline crossing which result in reduction in efficiency of the action (9). According to other studies, midline crossing also can be related to different variables such as learning disabilities (25, 26). Other features of this meaning, which have interested many growth specialists, drives from the relation between this concept and the developmental trend of preferred hand and also the differences in the amount of the midline crossing at different ages (2, 6, 7). For example, Carlier, Doyen, Lamard (2006), conducted a study on children between the ages of 3 to 10, concluded that older children perform midline crossing more frequently in comparison to younger children (7). Pryde,

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Bryden, Roy, (2000)also studied the usage of hand among people between the ages of 3 to 24, and according to the results, children between 3 to 4 and adults used preferred hand in the contralateral hemispace less frequently, which shows a reduction in body midline crossing. On the other hand, children between the ages of 6 to 10 showed high tendency in using their preferred hand in all parts of the hemispace; this confirms the concept of growth process and the effect of the age on the midline crossing (4). Another factor, which has been focused in some researches, is the variable of motor dominancy or handedness (22). Indeed, based on searches done, many of studies have focused on the effect of dominant limb among the group ages of children and infants (2, 6, 8, 17, 27).

Based on the recent studies, especially studies on children, the two new concepts, the attentional need related to the object locations and task complexity can affect the hand selection in the contralateral hemispace (12,18,19,23). Now, the question is that whether just the effect of these factors is restricted to the childhood; is the significance sequence of these variables the same for all age periods. considering different features of children and adults in the process of reaching and hand selection, and in view of the limited background of studies about these factors in the researches about adults comparing to children, this research is trying to study the effects of task complexity and object location on the frequency of body midline crossing among adults.

2. Method:

2.1. Participants:

This research statistical universe consisted physical education students of Mashhad University. Following performing, Aneet handedness questionnaire (Aneet 1970), 85 female and male subjects (39 female and 46 male) were selected among qualified people (strong right handed and healthy, age range= 18 to 25) as statistical sample (1).

2.2. Procedure and task:

Implementation method and tools employed in this research were extracted from Mamlo et al, (2004) (21). Five tools were placed in five positions with 45 intervals on a half circle with diameter 30cm. position 1 was in far right, position 2 in near right, position 3 in midline and positions 4 and 5 in near left and far left. Used tools included pencil, paintbrush, small knife, small plastic saw, and a small hammer. According Waterloo's handedness questionnaire these tools require most recalling of preferred hand.

Each participant was seated at a table in front of the experimental apparatus with his/her hands resting on the table. Then experimenter randomly asks subjects to accomplish one of following tasks with objects: 1.simple lifting of objects, 2. pantomime the use of the tool (first lifting the object and then its Pantomime 3. Real use (first lifting and then performing the action). In this test, subjects were asked to perform respective action naturally and quickly. In this case, experimenter stands before subject and records data related to each effort. Efforts related to each tool and actions were recorded in combined form and randomly in a 15-effort set format. After finishing the first block, tools' location is changed so that each tools is placed in a specified position. At the end, each subject should accomplish 75 efforts.

2.3. Statistical analyses:

Regarding the fact that each variable has different aspects (task =3, location = 5), research design is inter-group design and multifactor variance analysis (3.5) with repeated measures was used for variable study. Furthermore, Different tests such as, ANOVA, and MANOVA were used for determine the effect of each variable and interaction of them on frequency of preferred hand use.

3. Results:

Based on the results of this study, the frequency of reaching with preferred hand in near right and far right point was at the maximum. Of course, only one participant of reaching with the left hand for the far right spot were observed, and considering the near-zero variance in far right and near right spots, and in view of the concept of midline crossing, the information for three spots of midline, near left and far left were used. Based on findings of this research the task effect was significant on frequency of using preferred hand ($p=0.000$, $F=23.351$); that is, by increasing level of task difficulty, preferred hand recalling also increases. According to statistical results, most use of preferred hand was observed in real use task ($M= 24.99$) and then in pantomime action ($M = 24.89$) and finally in simple lifting ($M = 23.78$). regarding Tukey's follow up test,

it was found that there is significant difference between a mean frequency of preferred hand reaches in lift task and two other tasks (pantomime and real use) (p = .000), while this difference was not observed in pantomime and real use tasks (p = .873). According to results, object location has also impact on frequency of reaching with preferred hand (F=17.113 p=.000). Thus after position 1&2 in ipsilateral hemispace more reaching was observed with preferred hand in midline position (M = 14.91) compared to near (M = 14.68) and far left position (M = 14.12). However, using Tukey's follow up test didn't show differences between far and near right, midline and near left position. Then it was found that reaching frequency mean with preferred hand in far left position is significantly less than other positions (p = .000).

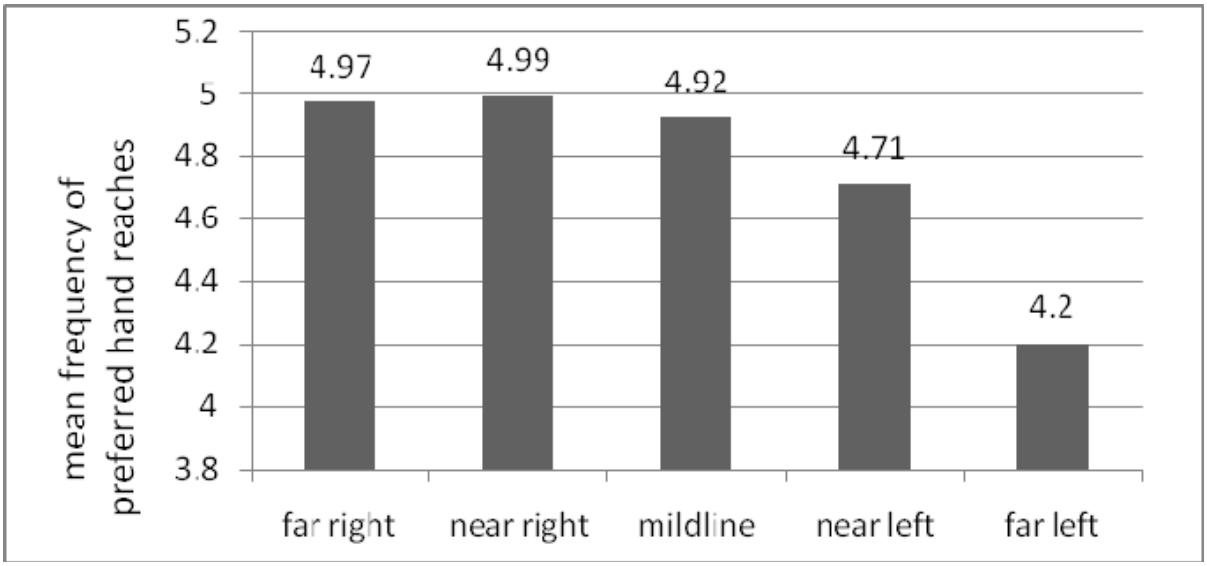

Figure1. The mean frequency of preferred hand reaches at each position for right-handed participants.

However, regarding combination and interaction of task and object location variables it was found that there is significant difference between different tasks in different positions (p = .000, F = .059), it also was found that mean frequency of using preferred hand in far left position for lift task (M = 4.2) has significant difference with two other tasks (pantomime mean=4.929 & real use mean=4.988) (p = 0.000).

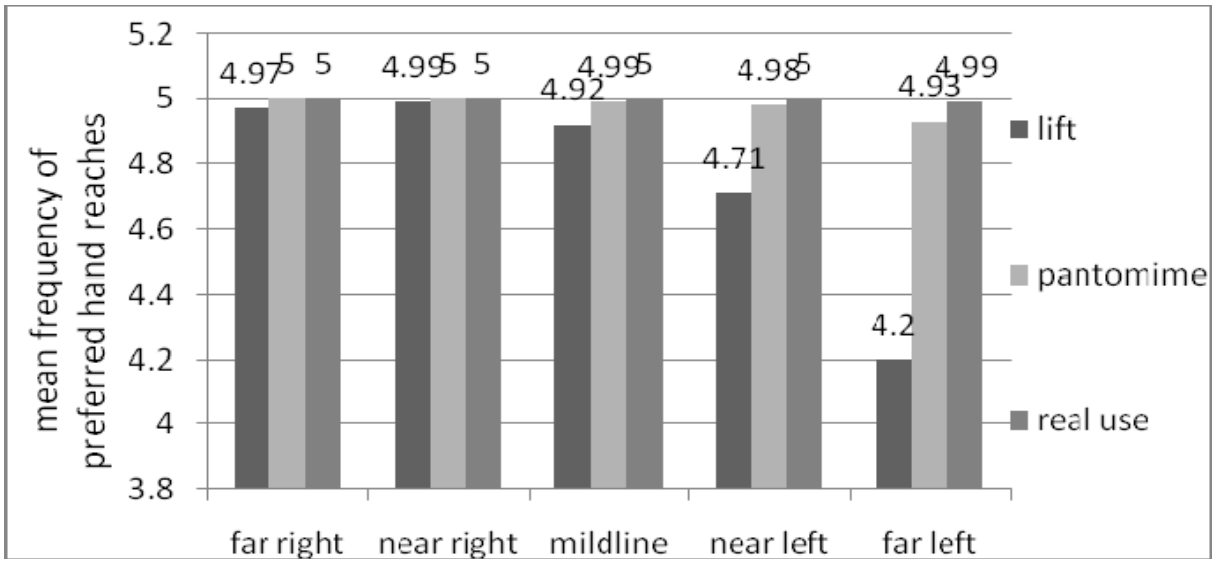

Figure2. The mean frequency of preferred hand reaches at each position for right-handed participants. The frequency of preferred hand reaches was summed across the five tools to give a maximum possible score.

4. Discussion:

This study aims to evaluate factors affecting midline crossing and, in order for that to happen, variables affecting hand selection in working space, especially factors affecting hand selection in contralateral hemispace were studied. This research evaluated the interaction between the factors associated with attentional features related to the objects location and task demand. Based on the results, the variable related to the location of objects had impact on the frequency of reaching with preferred hand in adults. Thus with regard to the fact that almost all ipsilateral reaching efforts were performed with preferred hand, this amount changed significantly in contralateral hemispace so that frequency of reaching with preferred hand in far left position reduced significantly compared to other positions, especially positions related to ipsilateral hemispace and midline spot. These findings is consistent with the observations of Gabbard, Helbig (2004), Gabbard, Helbig, Gentry (2001), Gabbard, Rabb(2000), Mamolo, Roy, Bryden, Rohr (2006) (10, 11, 13, 20).

On the other hand, with regard to effect of task demand, frequency of using preferred hand in different tasks changed significantly. This concept result to this that people prefer to cross body midline for performing pantomime actions and real use in contralateral hemispace with respect to biomechanical non efficiency of these movements. This indicates increase of recalling preferred hand regarding increase of task difficulty level. Based on review of related literature these findings are consistent with (20, 21), but it is not concur with observations (5) showing no effect of this variable on limb selecting, and observations (12) showing the effect of hemisphere bias on limb selecting in contralateral hemispace, or, in other words, the tendency of the body for doing actions with ipsilateral hand.

Based on these findings, and considering their resemblance to the results of the studies on children, it is suggested that the variables of task demand and the objects location are effective among the groups of adults, as for children, and adults, consider this variables for hand selecting in different region, even contralateral hemispace same as children. However, at a closer look, this question is raised: is the amount of preference of each of these factors the same among adults and children; in other words, do adults and children react in the same way to all existing variables. Based on Bryden and Roy (2000), children at the ages of 3 and 4, same as adults, use their preferred hand in all spaces less frequently, comparing to the children between the ages of 6 to 10 (4). This concept can be explained this way: children move from accidental reaching with their hands at earlier ages toward fixed reaching with their preferred hand in all spaces (3). Of course, this much usage could explain by much practice and using preferred hand during the education period (11). It seems that the sequence of the effects of the variables differs among groups of adults and children, meaning that children at the ages of 6 to 10 use less flexible strategies for movements and it is because they are dealing with the process of movements refining (15). finally, based on the concepts mentioned in this study, it can be suggested that different factors can affect the hand selecting in contralateral hemispace or on midline crossing, on the other hand, based on dynamic system view, it seems that all environmental, biological factors and task demand, can affect hand selection in children and adults. However, in each age period the prominence of each of these factors changes. This way, it may be suggested that during the childhood, individual features or motor dominance is the most important factor for hand selecting in contralateral hemispace, and in adulthood attentional features of the environment and task demand replace motor dominance.

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