Frequency of hand use in healthy older persons

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The aim of this study was to describe the type and frequency of hand use in healthy older adults. Observational studies were conducted involving structured observations at five-minute intervals on 15 healthy older adults as they went about their normal daily routine between 10.00 am and 2.00 pm. Overall, the dominant hand was used more frequently than the non-dominant hand. Subjects used their hands predominantly to hold and manipulate objects, and not for balance. There was no significant difference between the frequency of manipulating objects with the fingers and the frequency of use of the whole hand. Subjects used their hands significantly more often in bimanual activities than in unimanual activities or in no activity. Although subjects usually stood while they held or manipulated objects, they also sat or walked while manipulating them. The present study provides insights into how healthy older adults naturally use their hands in performing everyday activities. While the dominant hand is used more than the non-dominant hand, the hands are used predominantly together to perform bimanual tasks.

Methods

Subjects Fifteen volunteer subjects, including 10 women and five men, aged between 59 and 77 years (mean ± SD, 66 ± 7 years) participated in the study. No subjects had a history of neurological or musculoskeletal disabilities that would affect the use of the upper limb and all subjects were observed in and about their homes. All subjects were retired or worked only on a part-time basis so that observations occurred on days when the subjects were at home. Subjects were not informed of the specific aim of the study, although they were informed of the methods. The university human ethics committee approved the study, and all subjects signed a consent form before data collection.

Procedures The observational study consisted of a behavioural map in which samples of the motor activity of the subjects were taken at five-minute intervals from 10.00 am until 2.00 pm. One observer recorded data from five subjects, and a second observer recorded the data from the remaining 10. Specifically, at every five minutes the observers recorded what subjects were doing with their hands, in what position they were doing the task, and in what location they were, using the categories and codes shown in Table 1. An example of a partially completed data sheet is shown in Table 1.
Prior to observing subjects for the study, pilot work was carried out to determine the classification, and quantity of information that could be obtained reliably and the appropriate period to observe subjects. Codes used for the tasks performed by the left and right hand were determined from observation of one subject over a period four hours. To test the reliability of coding, two observers recorded the activity of one subject over a period of three hours. The percentage of exact agreement between coders was 100%. To identify the period of time over which observation would occur, a preliminary study on five subjects was undertaken. These subjects were observed from 8.00 am to 6.00 pm for three weekdays. From these observations we determined that the period from 10.00 am to 2.00 pm would provide us with a period in which subjects would likely be using their hands to perform normal daily tasks. The data from the first day of testing, between the times of 10.00 am and 2.00 pm, were then used with that from the additional subjects.

A checklist was used to structure the observations (Table 1). In the first column of the checklist, bimanual, unimanual or no activity was categorised. Bimanual activity indicated that the subject was using both hands, although not necessarily performing the same task with the two hands at the time of observation, whereas unimanual activity indicated that only one hand was in use. Hand usage was categorised under the following headings: grasp, gesture, stabilise, support and push and no activity. When ‘grasp’ was recorded, it was further differentiated between that which involved only the digits (e.g. in the pinch or key grip, Napier 1956) and that which involved the whole hand (e.g. power grip, Napier 1956). In addition, the observer recorded the action the subject was performing at the time of the observation.

‘Grasp’ was defined as holding an object with or without moving it about within the hand. ‘Stabilisation’ was defined as the use of the hand or digits to prevent an object from moving, for example holding a piece of paper while using the other hand to write, or holding toast while using the other hand to butter the toast. ‘Pushing’ referred to depressing a button or lever, for example the on/off switch of a blender, the keys of a computer or the buttons on a phone. ‘Support’ was selected if the hand and arm were used in balancing, for example holding onto a counter while putting on a shoe. ‘Gesture’ referred to the use of fingers and/or hand to emphasise a point or express a thought.

Subjects were informed that the observer would record their activities every five minutes, with the exception of locations where privacy was required, for example the bedroom and bathroom. Thus, 48 observations were obtained for 10 subjects, 47 for one subject, 46 for one subject, 44 for two subjects and 39 for one subject. In addition to recording activities within and around the subject’s home, the observer also went with the subjects while they shopped, and, in the case of one subject, to the local golf course. Subjects were requested not to change the activities they had planned during the day, and to ignore the observer who was under instructions not to make eye-contact or talk with the subject.

Data analysis For each category of observation, the frequency of each code was determined. The scores for categories were tallied to produce an index of use. Parametric tests, including repeated measures analysis of variance (ANOVA) were then used to determine whether there were significant differences: (i) in the frequency of bimanual activity versus unimanual activity versus no activity; (ii) in the type of grasp employed by the subject; (iii) in types of functions performed by the dominant and non-dominant hands; and (iv) in the posture of the subject in performing the different functions. Paired t-tests were also used to test for differences in frequency of function between the dominant and non-dominant hands. Significance was set at $p = 0.05$.

Results

The majority of activities involved the use of both hands. Overall, 54% ($\pm 10\%$) of the observations involved bimanual activity whereas only 29% ($\pm 10\%$) involved unimanual activity and 17 ($\pm 7\%$) involved no activity. The difference among the three categories was significant ($p < 0.001$), with planned contrasts indicating that bimanual activity occurred more often than unimanual activity and no activity, and unimanual activity occurred more often than no activity.

Hand function was coded under the following headings: grasp, gesture, stabilise, push and no activity. Table 2 records the percentage of observations in which subjects performed each of these functions. Overall, subjects used the dominant hand more than the non-dominant hand ($p = 0.03$) and were observed more often using the hands to grasp objects than to perform functions such as depressing levers, gesturing, stabilising objects and supporting themselves (Table 2; $p < 0.001$). Analysis of these data also revealed an

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Table 1. Example of a completed behavioural map used to record the activity from 10.00 am to 10.15 am for one subject, using the codes in the key.

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity*</th>
<th>Right hand Function†</th>
<th>Grasp‡</th>
<th>Left hand Function†</th>
<th>Grasp‡</th>
<th>Posture§</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>Opening small bottle</td>
</tr>
<tr>
<td>10.05</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>Holding steering wheel</td>
</tr>
<tr>
<td>10.10</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>Lifting golf bag out of car</td>
</tr>
<tr>
<td>10.15</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>Pulling golf buggy</td>
</tr>
</tbody>
</table>

*0, no activity. 1, unimanual. 2, bimanual.
†1, no activity. 2, grasp. 3, stabilise. 4, push. 5, gesture. 6, support.
‡1, digital. 2, whole hand.
§1, sitting. 2, standing. 3, walking. 4, kneeling. 5, lying down. 6, bending over.
interference effect between the hand performing the task and the function performed, indicating that some functions were performed more frequently with the dominant hand whereas other tasks were performed more frequently with the non-dominant hand. As there were very few observations classified as gesture, stabilise and push, they were combined in all further analyses as ‘other’.

Paired t-tests of the dominant and non-dominant hand ‘functions’ (i.e. grasp, support, other and no activity) showed that subjects grasped objects more frequently with the dominant hand ($p = 0.002$) but performed the other functions equally with the dominant and non-dominant hands. Also, the non-dominant hand was observed more often not performing any activity ($p = 0.03$).

For observations in which either the dominant and/or non-dominant hand was grasping, the type of grasp was identified. We recorded whether the task involved only the digits (e.g. pinch or key grip (Napier 1956)) or whether the task involved the whole hand, including the palm (e.g. power grip (Napier 1956)). Although the figures in Table 2 suggest that digital grasps were used more frequently than whole-hand grasps, these differences were not statistically significant.

Although subjects sat and stood equally during the four-hour observation period, they actually spent more time walking while holding an object ($17.4 \pm 14.1\%$) than on the ‘skill’ with which the hand was used. The results from this study provide empirical data in support of some specialisation of hand usage. Specialisation was not in the type of activity performed by each hand, but in the frequency of the observed behaviour. For example, the dominant hand was used more often than the non-dominant hand over the observation period (72.5% versus 63.7% of the observations).

**Discussion**

Observations of healthy older subjects in their natural environment between 10.00 am and 2.00 pm revealed a number of interesting findings. Typically, the subjects used their hands in bimanual activities. Overall, the dominant hand is used significantly more than the non-dominant hand. Furthermore, hands are used predominantly to hold and manipulate objects, and not commonly for support. Over the observation period, subjects held objects more frequently while standing and sitting, and less often while walking.

The present study focused on frequency of hand usage rather than on the ‘skill’ with which the hand was used. The results from this study provide empirical data in support of some specialisation of hand usage. Specialisation was not in the type of activity performed by each hand, but in the frequency of the observed behaviour. For example, the dominant hand was used more often than the non-dominant hand over the observation period (72.5% versus 63.7% of the observations). The biggest difference between the hands was in the frequency with which subjects grasped an object. The dominant hand was observed grasping objects approximately 1.3 times (range: 0.82 – 2.2) more often than the non-dominant hand, although the ratio of digital versus whole hand grasp was similar. Grasp was only recorded as digital or whole hand because other types of classification, such as the number of virtual fingers involved (Arbib 1990), could not be reliably identified.

Bimanual activities comprised 54% of the observations, whereas unimanual activities only comprised 29.4%. Unimanual activity was observed more often than bimanual activity in only one subject (38.3% versus 36.2%, respectively), and was observed equally often in another subject (48%). In the remaining 13 subjects, bimanual activity was observed more often than either unimanual or no activity. The percentages for bimanual activity may be slightly under-represented as subjects were not observed in situations in which privacy was required, such as the bathroom or bedroom. However, as we recorded 700 of a possible 720 observations, missing data are unlikely to affect the results significantly.

During the course of the observation period, subjects performed other bimanual tasks such as changing their clothes, performing toileting activities, washing their hands, and performing a wide range of activities out of view of the recorder. Three broad categories of bimanual tasks were identified in the present study: i) the upper limbs performed cooperatively in symmetrical movements (e.g. using a rolling pin; carrying the laundry basket); ii) in other tasks, the hands were used asymmetrically but cooperatively (e.g. pouring juice from a jug into a glass held by the other hand); and (iii) in yet other tasks, each hand serves diverse unrelated functions (e.g. holding a bag in one hand while opening a door with the other).
The findings from the present study have important implications for retraining upper limb function following brain damage. The current emphasis in retraining upper limb function is to focus only on the affected limb, with the patient seated. There has been an assumption that if a patient can perform unimanual tasks, the patient will also be able to perform bimanual tasks. However, bimanual tasks require interlimb co-ordination. The lack of practice of bimanual tasks may result in less recovery of interlimb co-ordination, impeding the patient’s ability to perform a bimanual task. As the frequency with which bimanual tasks are carried out by neurologically normal subjects in everyday situations is high, there appears to be a need to include some bimanual training. Furthermore, there is evidence that training bimanual tasks results in significant improvement in performance of functional tasks with the impaired upper limb (Mudie and Matyas 1996, Whitall et al 2000).

Upper limb function, and specifically hand function, is typically trained with the patient sitting at a table (Platz et al 2001). However, the present study revealed that healthy older persons actually spend more time standing while grasping objects than sitting while grasping objects, at least between 10:00 am and 2:00 pm. Furthermore, subjects also walked (17.4%), and used other positions such as kneeling and bending over (4.4%). To promote flexibility, and as a progression to training, positions other than sitting should therefore also be included while training hand function.

In the present study, the characteristics of the objects with which the subjects interacted were quite diverse: object size ranged from holding a needle to holding a laundry basket; texture ranged from smooth (e.g. steering wheel) to rough (e.g. toast); and compliance ranged from firm/rigid (e.g. cup) to compliant (e.g. banana, slice of bread). The characteristics of an object influence how an object is grasped (for review, see Johansson 1996). For example two characteristics, weight and texture, have been shown to be significantly related to grip force: heavier objects and objects with low frictional texture, have been shown to be significantly related to grip force (for review, see Johansson 1996). For example, two characteristics, weight and texture, have been shown to be significantly related to grip force: heavier objects and objects with low frictional coefficients both are associated with greater grip force (Johansson and Westling 1984). As characteristics of an object influence how the object is grasped, a wide range of objects with different characteristics should be used in retraining hand function.

Conclusion

The present study has provided some insights into how healthy adults use their hands in performing everyday activities. These insights may reflect the period of time over which the observations were made, which included preparing and eating a meal. We found that while the dominant hand is used more than the non-dominant hand, the hands are used predominantly to perform bimanual tasks.

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References


