TITLE PAGE

TITLE:

Relevance of grasp types to assess functionality for personal autonomy

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ABBREVIATED TITLE:

Relevance of grasp types to assess functionality

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ABSTRACT AND KEY TERMS

ABSTRACT

Study Design: Cross-sectional research design.

Introduction: Current assessment of hand function is not focused on evaluating the real abilities required for autonomy.

Purpose of the Study: To quantify the relevance of grasp types for autonomy in order to guide hand recovery and its assessment.

Methods: Representative tasks of the ICF-activities in which the hands are directly involved were recorded. The videos were analysed to identify the grasps used with each hand, and their relevance for autonomy was determined weighting time with the frequency of appearance of each activity in disability and dependency scales. Relevance is provided, globally and distinguishing by hand (right-left) and bimanual function. Significant differences in relevance are also checked.

Results: The most relevant grasps are pad to pad pinch (31.9%), lumbrical (15.4%), cylindrical (12%), and special pinch (7.3%) together with the non-prehensile (18.6%) use of the hand. Lumbrical grasp has higher relevance for the left hand (19.9% vs. 12%) while cylindrical grasp for the right hand (15.3% vs. 7.7%). Relevancies are also different depending on bimanual function.

Discussion: Different relative importance was obtained when considering dependency versus disability scales. Pad to pad pinch and non-prehensile grasp are the most relevant for both hands, while lumbrical grasp is more relevant for the left hand and cylindrical grasp for the right one. The most significant difference in bimanual function refers to pad to pad pinch (more relevant for unimanual actions of the left hand and bimanual actions of the right).

Conclusions: The relative importance of each grasp type for autonomy and the differences observed between hand and bimanual action should be used in medical and physical decision-making.

Level of Evidence: N/A.

KEY TERMS

Grasp taxonomy, ICF, daily life activities, right and left hand, simultaneous use of hands

ABBREVIATIONS:

3FC-ICF-activities: activities classified within the ICF with a 3-figure code

ADL: activities of daily living

AROM: active range of motion

EGA: elementary grasp action

ICF: International Classification of Functioning, Disability and Health

WCoeff_ScDi: Weighting coefficient obtained from disability scales

WCoeff_SvDe: Weighting coefficient obtained from dependency scales

WHO: World Health Organization

1. INTRODUCTION

Performance of activities of daily living (ADL) is critical to ensure a full and autonomous life.[1] Most movements in ADL require object manipulation with a stable handgrip.[2] Therefore, a decrease in the grasp capabilities arising from pathologies of the hands can generate a loss of functionality. In the occupational field, hand disorders represent one third of all injuries at work.[3] As a consequence, the study of the ability to grasp has been a permanent concern in biomechanics[4–7] and rehabilitation.[8–10]

However, current assessment of hand function in clinical practice lacks a deep evaluation of the grasp ability. Some assessment methods are based in tests or scales that are usually validated for specific pathologies.[11–13] They are highly subjective,[14] including sometimes self-rated scales. Other more general methods are based on objective data such as active ranges of motion, tactile sensing or grasp strength, although these methods are still under research.[10,15–19] Few methods evaluate the performance of some types of grasps, but they do not consider their relative importance for developing normal life.[13,20]

The International Classification of Functioning, Disability and Health (ICF) of the World Health Organization (WHO) was developed as a framework for evaluation.[21] The ICF provides a standard language and a common framework to compare by using a common metric: the impact on the functioning of the individual. The ICF considers positive functioning as the situation where the body is functional and with structural integrity, thus allowing the normal performance of activities and participation. The ICF develops these activities in its part ***d. Activities and Participation.*** The terms disability and dependency are often used interchangeably in the literature.[22] Some works[23] point out the lack of international consensus on the definition of concepts such as disability, functioning, autonomy, sufficiency or dependency. According to the ICF,[24] functioning and disability are related domains of a single health construct. Functionality, as opposed to disability, is the capability to perform a

specific activity. Some authors [23] propose that autonomy (equivalent to sufficiency) and dependency are part also of another single construct. In this construct, dependency can be defined as a loss of autonomy and the need of support by a third person for ADL, especially self-care. A high grade of disability leads inevitably to dependency, but disability can exist without dependency. Full autonomy or sufficiency is reached when a person can develop all the necessary ADL for total functionality. In this sense, personal habits, roles and responsibilities of one person may influence the perception of autonomy of an individual. However, the scales used to rate both disability and dependency are common and general.

In fact, there are two issues to be considered when rating disability or dependency by assessing the capability to perform ADL: the selection of ADL and the relevance of the selected activities for autonomy. There is no consensus in which ADL must be considered for autonomy.[20,25,26] In fact, the scales often consider for autonomy only some basic activities such as those of self-care, so that a person might be assessed as autonomous although he/she requires assistance to carry out activities such as cooking, shopping or going outside. All ICF-activities should be considered when using the ICF to assess autonomy, and a key question is establishing the importance of each activity for personal autonomy. In this regard, a worth mentioning study by Querejeta[22] collects a review of ratings applied by several European countries and organizations, summarized in two ratings that will be used in this work. The first rating measures the importance of each ICF-activity for disability, computed from the frequency of appearance (appearance coefficient, in %) of each ICF-activity in 23 scales used to globally rate disability, as Barthel Index, Functional Independence Measure or Katz Index. The second rating takes into account the importance of the activities for dependency, estimated through the frequency of appearance of the activities in several sociological surveys of public health in Spain. Both scales are not equivalent: the scales of disability give more importance than the surveys of dependency to transferring oneself or

speaking, and less importance to household tasks (preparing meals, doing housework), the acquisition of goods and services, moving around and using transportation or recreation and leisure. Obviously, this dependency rating of the ICF activities has to be seen as a general rating, which may differ somewhat from particular individual's perceptions, affected by the personal habits, roles and responsibilities.

Knowledge of the daily frequency of usage of the different grasp types, along with time of hands working in unimanual or bimanual tasks, has been emphasized as essential to establish rehabilitation strategies.[27,28] Daily frequencies of different grasp types while performing ADL were provided in a previous work by the authors.[27] Nevertheless, that work was not focused on assessing disability but on daily time of use. The most commonly used grasps throughout the day are not necessarily the most important ones for autonomy; at least there is no evidence of it to date. Knowledge of the most needed grasps for autonomy would be a valuable reference in decision-making for medical and physical rehabilitation to reinforce the capacity to perform these grasps. In fact, 97.5% of therapists feel that ADL-based strategies are important in hand therapy practice.[29] However, assessing the capability to perform different grasp types is not a common practice to assess functionality. Light et al.[20] attempted to assess functionality through the capability to perform different grasp types by assigning a unique grasp type to each activity, although different grasp types are usually required to complete a given ADL. They used a limited set of ADL as representative of the grasp types most commonly used, but they didn't weight the activities for autonomy. No previous work has attempted to establish the relevance of the different grasp types for assessing functional recovery or disability.

The objective of this work is to present the relevance of the different grasp types for disability assessment, within the framework of the ICF. A field study has been performed on healthy subjects to identify the grasps used during normal hand function by means of a thorough

analysis of videos recorded while performing a set of activities selected according to the ICF. The importance of each grasp for autonomy is estimated using weighting coefficients obtained from the work of Querejeta.[22]

2. MATERIAL AND METHODS

The experiment was approved by the Ethical Committee of the University. Thirty-two right-handed subjects (16 males and 16 females) participated in the experiment (age 32.4 ± 12.5 years, hand length 180 ± 13 mm and hand breadth 81 ± 9 mm). All the participants were free of pathological conditions.

First, a set of ICF-activities in which the hands are directly involved was selected. Then, representative tasks accounting for each of these ICF-activities were recorded on video. The videos were subsequently analysed to identify the different grasps being used, and finally the importance of each grasp type for autonomy was determined.

2.1 SELECTION AND RECORDING OF TASKS

From the ICF part ***d. Activities and Participation***, the activities of the 3rd level (Subclass of the ICF up to a 3rd level, coded as d followed by 3 figures) were used in this study (Table 1), named as 3-figure code ICF-activities (3FC-ICF-activities), although we have looked into the activities of the 4th level, (Subclass of the ICF up to a 4rd level) if they existed, in order to select the representative tasks.

Insert Table 1 here

ICF chapters where the hands are not involved were not considered and neither were those referring to cognitive activities (how to learn, how to manage relationships, etc.). In all, chapters 3 (Communication), 4 (Mobility), 5 (Self-care), 6 (Domestic life) and 9 (Community, social and civic life) were considered. Within these chapters, 23 3FC-ICF-

activities in which the hands are directly involved for grasping were identified by the authors. Some 3FC-ICF-activities were not considered, such as *d340 Producing messages in formal sign language*, as no grasp is required; *d480 Riding animals for transportation,* because it is only used in developing countries; and *d420 Transferring oneself*, as it requires the use of the hands simply as a fulcrum. Then, a total of 128 representative tasks of these 3FC-ICF-activities were selected and recorded on video (Figure 1). Each subject performed a reduced set of the tasks, and each task was performed by several subjects. When different ways of performing a given task (in terms of types of grasps) were found, more than one video was analyzed per task, so that 145 videos were finally thoroughly analysed as being representative of the 128 tasks.

Insert Figure 1 here

2.2 ANALYSIS OF THE TASKS RECORDED

First, each task was divided into consecutive elementary grasp actions (EGA) for each hand, considered as any complete action in which the hand performed a particular action using a fairly constant hand posture. Close to 2300 EGAs were analysed to identify the hand involved (right or left), the type of grasp used from a 9-type classification[27] (Figure 2), the total time spent in the EGA and whether at any time during the EGA the task is bimanual or not. The nine types of grasps considered were enough to represent the grasping postures used for most of the EGA (97%) and included both power and precision grasps, as well as a non-prehensile grasp (objects are manipulated without being grasped).

Insert Figure 2 here

2.3 ANALYSIS OF DATA

As the durations of the videos for each task were very different, the time recorded for each EGA was weighted in order to equal the time of all the tasks within each 3FC-ICF-activity, and afterwards to equal the time of all the 23 3FC-ICF-activities recorded.

In order to consider the importance of each grasp type for disability and dependency, two additional weighting coefficients were used from the appearance coefficients by Querejeta[22] (Table 2): one of them rating the importance of the activity in scales of disability, Wcoeff_ScDi, and the other rating the importance of the activity in surveys of dependency, WCoeff_SvDe. In order to calculate the weighting coefficients for each of the 3FC-ICF-activities, the appearance coefficients have been scaled to one-hundred basis points. For those activities not considered in the work of Querejeta, the coefficient of the most similar activity was used (e.g. for *d345 Writing messages*, the code *d335 Producing nonverbal messages* is applied instead, because it has a broader meaning and belongs to the same group *Communicating-producing* activities).

Insert Table 2 here

The global relevance of each grasp was calculated as the percentage of weighted time of each grasp type out of the total weighted time analysed. In a global analysis, the relevance was calculated by using the two importance scales WCoeff_ScDi and WCoeff_SvDe. Using only the coefficient WCoeff_ScDi, the relevance of each grasp type was also calculated distinguishing by hand involved (left/right), and by whether the action was bimanual or not. Descriptive statistics are presented, and contingency tables and χ^2 computed to check significant differences. More specifically, 2x2 contingency tables were computed for each type of grasp (one grasp/the rest of grasps) versus the hand involved (left/right), and versus the bimanual function (unimanual/bimanual). All the analyses were performed using IBM SPSS Statistics 23.

3. RESULTS

The relevance of the different grasps is presented in the graph in Figure 3. The highest values corresponded to pad to pad pinch, non-prehensile, cylindrical and lumbrical grasps. The relevance of the grasp types in the scales of disability and in the surveys of dependency differs slightly, especially for the case of the pad to pad pinch grasp. It appears to be much more important than all the other grasps in the scales of disability, while for dependency is at the same level as non-prehensile, cylindrical and lumbrical grasps. Comparing the results from Figure 3 with the frequency of daily usage of the grasps[27] shown in Table 3, important differences can be observed in the oblique palmar and non-prehensile grasps.

Insert Figure 3 here

Insert Table 3 here

Relevance of the different grasps distinguishing by hand (left-right), is presented in Figure 4. The χ^2 test revealed significant differences for all the grasps, except for hook (bilateral asymptotic significance < 0.05). Thus, the relevance of each grasp is different for the dominant and non-dominant hands, with highest relevance for the pad to pad pinch grasp. The pad to pad pinch grasp was followed in relevance by the non-prehensile and lumbrical grasps for the left hand, far from the rest of the grasp types. However, the cylindrical grasp gained importance for the case of the right hand, being at the same level as the non-prehensile grasp, followed by the lumbrical grasp.

Insert Figure 4 here

Relevance of the grasps distinguishing by hand (left-right) and by bimanual function is presented in Figure 5. The χ^2 test revealed significant differences for all the grasps (bilateral asymptotic significance < 0.05). In the case of the left hand working alone, an important degree of relevance was found for the pad to pad pinch grasp, followed by lumbrical and non-prehensile grasps, whereas, in bimanual tasks, relevancies of these three grasp types were

more or less equal. Conversely, in the case of the right hand, relevance of the pad to pad pinch grasp was much higher in bimanual tasks. For the right hand in bimanual tasks, the non-prehensile grasp also showed a high degree of relevance, followed by lumbrical, cylindrical and intermediate power-precision grasps. When the right hand was working alone, similar relevance was observed for the pad to pad pinch and cylindrical grasps, followed by the lumbrical, non-prehensile and lateral pinch grasps.

Insert Figure 5 here

4. DISCUSSION

The comparison of the relevance obtained in this work and the daily frequency usage of each grasp type from a previous study[27] has verified that the most frequently used grasps throughout the day are not the most important grasps for autonomy. The oblique palmar grasp, one of the most used grasps, has been rated with very low relevance for autonomy. This could be due to the large amount of time spent daily on activities such as driving, where the oblique palmar grasp is used for manipulating the steering wheel. Conversely, the non-prehensile grasp is not used so much throughout the day, but it has been rated as the second grasp in terms of relevance for autonomy, probably because of the high weighting coefficient of the 3FC-ICF-activity *d410 Changing basic body position*, where the non-prehensile grasp is present. Nevertheless, the differences between daily time of use and relevance must be taken with care, as the selection of activities was not the same because the purposes of the studies were different.

Furthermore, this study has shown a difference between the relevance of some grasp types for scales of disability and for surveys of dependency. Pad to pad pinch is considered in dependency scales as less relevant than in disability surveys, in opposition to cylindrical grasp, therefore giving more importance to power grasp than to precision grasp. However, the

relative importance of the grasps for autonomy computed in this way only reflects the perception about autonomy from the evaluators of the hand function, and may not match with the patient's perception. Although particular individual's perceptions are affected by the personal habits, roles and responsibilities, more research is desirable to obtain a general scale of dependency of the tasks based on the patient's perception.

It is worth mentioning that the most relevant grasps were the ones in which the thumb is in opposition to the palm and adducted (pad to pad pinch, cylindrical, lumbrical). Within precision grasps, pad to pad pinch is the most relevant, at a great distance from the lateral and special pinches. Within power grasps, cylindrical and lumbrical grasps are the most relevant, much more than the oblique palmar grasp. These three grasps (pad to pad pinch, cylindrical, lumbrical), together with the non-prehensile one, represent almost 80% of relevance for autonomy, which should be considered in rehabilitation strategies. Instead of focusing on ensuring grasp capabilities, physical therapy strategies are usually aimed at improving the AROM and strength, on the basis that maximizing these capabilities will ensure the performance of all grasps required for ADL. The rehabilitation process ends once there is no increase in AROM or strength, with no objective assessment of the actual level of recovery of functionality achieved. Assessing the capability to perform the main grasps for relevance could give an insight into the level of functionality restored.

The most relevant grasps found in this work (pad to pad pinch, cylindrical and lumbrical) are used in the Southampton Hand Assessment Procedure (SHAP),[20] while the Sollerman hand function test[13] does not include the lumbrical grasp, based on an estimated 2% percentage of use in ADL, which does not agree with more recent studies[27] that report values about a 10%. Current hand function tests could be improved by considering a weighting coefficient of the relevancy of grasp types for autonomy.

The relevance of each grasp has been evidenced to be significantly different depending on the hand, right or left, so that different rehabilitation goals should be considered for dominant and non-dominant hands. The pad to pad pinch, lumbrical and special pinch grasps should be considered more especially in non-dominant hand rehabilitation, whereas pad to pad pinch, cylindrical and lumbrical grasps should be trained in dominant hands.

Moreover, for both left and right hands, the relevance of each grasp types depends on whether the action is bimanual or not. This fact should be taken into consideration when full recovery is difficult. In these cases, rehabilitation should focus on training the most relevant bimanual grasps. In addition, if the dominant hand is severely affected but the other hand remains in good condition, the non-affected one will probably become dominant, and rehabilitation should be oriented in this sense.

Even though valuable new data are provided about the relevance of the different grasp types for autonomy, results should be taken with caution. Some limitations may arise from the set of activities selected, although care was taken to be as representative as possible of the ADL required in developed countries. Furthermore, the results are dependent on the weighting coefficients used, which can differ slightly for different social environments. In particular, weighting coefficients used to rate dependency were obtained from the frequency of appearance in sociological surveys in Spain.

Despite these slight limitations, the results derived from this study could be used as the basis for the development of objective assessment tests, but also to reinforce the rehabilitation process by using serious games, which have been demonstrated as an efficient rehabilitation method.[30,31] These games should be focused on training the different grasps according to their importance for autonomy and should be designed so as to be entertaining with the intention of ensuring the player becomes highly involved.

The results obtained in this work might also be useful for prosthesis design. Prostheses should allow performance of the most relevant grasps, as ranked in this study. Furthermore, prosthesis design could be different depending on its use for a dominant or non-dominant hand. However, in the case of a patient who still has a healthy hand, the most appropriate strategy would probably be to always consider the remaining hand as dominant, and design the prosthesis for a non-dominant hand, thereby reinforcing bimanual grasping.

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7. TABLES

Table 1. Chapters of the ICF

CHAPTERS OF THE ICF		
d1	Chapter 1	LEARNING AND APPLYING KNOWLEDGE
d2	Chapter 2	GENERAL TASKS AND DEMANDS
d3	Chapter 3	COMMUNICATION
d4	Chapter 4	MOBILITY
d5	Chapter 5	SELF-CARE
d6	Chapter 6	DOMESTIC LIFE
d7	Chapter 7	INTERPERSONAL INTERACTIONS AND RELATIONSHIPS
d8	Chapter 8	MAJOR LIFE AREAS
d9	Chapter 9	COMMUNITY, SOCIAL AND CIVIC LIFE

Table 2. Weighting coefficient applied

3FC-ICF-activity	code applied	appearance coefficient		weighting coefficient applied	
		scales of disability	surveys of dependence	scales of disability	surveys of dependence
d325	d315	15%	20%	1.90	1.75
d335	d335	15%	20%	1.90	1.75
d345	d335	15%	20%	1.90	1.75
d360	d350	15%	0%	1.90	0.00
d410	d465	55%	40%	6.96	3.51
d430	d430	20%	20%	2.53	1.75
d440	d440	25%	20%	3.16	1.75
d445	d430	20%	20%	2.53	1.75
d470	d470	20%	80%	2.53	7.02
d475	d475	10%	20%	1.27	1.75
d510	d510	70%	100%	8.86	8.77
d520	d520	70%	80%	8.86	7.02
d530	d530	75%	40%	9.49	3.51
d540	d540	70%	100%	8.86	8.77
d550	d550	75%	60%	9.49	5.26
d560	d560	75%	20%	9.49	1.75
d570	d570	45%	20%	5.70	1.75
d620	d620	20%	80%	2.53	7.02
d630	d630	20%	100%	2.53	8.77
d640	d640	20%	100%	2.53	8.77
d650	d640	20%	100%	2.53	8.77
d660	d660	5%	20%	0.63	1.75
d920	d920	15%	60%	1.90	5.26

Table 3. Percentage of grasp frequency and daily time of use of each grasp type, data from a previous study.[27]

	Cyl	Hook	intPP	LatP	Lum	nonP	Obl	PpPinch	SpP
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Grasp Frequency	12.3	2.9	3.3	8.8	9.7	12.7	5.9	38.3	2.8
Daily Time	9.4	2.3	5.8	6.6	10.9	7.6	11.9	36.9	5.7

8. FIGURE CAPTIONS

Figure 1. All the 3FC-ICF-activities considered involving the hands and all the tasks recorded within each of them (there are 128 tasks from 23 different 3FC-ICF-activities).

Figure 2. Examples of the grasp in the taxonomy. Cylindrical grasp (Cyl), Oblique palmar grasp (Obl), Hook (Hook), Lumbrical grasp (Lum), Intermediate power-precision grasp (IntPP), (Pad to pad Pinch PpPinch), Lateral Pinch (LatP), Special Pinch (SpP), Non prehensile grasp (NonP).

Figure 3. Relevance of the different grasps is presented both with Querejeta's scale of 3FC-ICF-activity presence in common tables and scales of disability (ScDi), and with the scale obtained from sociological surveys about dependency.

Figure 4. Relevance of the different grasps distinguishing by hand (left-right) is presented. ScDi is used.

Figure 5. Relevance of the different grasps distinguishing by hand (left-right) and by unimanual or bimanual tasks is presented. ScDi is used.

9. FIGURES

Figure 1.

TASKS RECORDED								
d3	COMMUNICATION		d4	MOBILITY		d6	DOMESTIC LIFE	
	d325	Reading a book or a journal		d410	Sitting in a dining chair		d620	Shopping items into boot
		Reading using a tablet			Sitting in an armchair			Handling trolley
	d335	Drawing			Standing up from a chair			Shopping: taking items
		Painting			Standing up from an armchair			Shopping: releasing items
		Taking photos		d430	Lifting objects			Shopping:paying
		Copying using a photocopier			Carrying objects in the hands			Shopping (vending machine)
	d345	Writting			Carrying backpack		d630	Cutting tomatoes
	d360	Talking using a telephone			Releasing objects			Peeling oranges (hand)
		Talking using a mobile		d440	Picking up toys			Peeling potatoes (knife)
		Using a smartphone			Picking up DVDs and CDs			Toasting a sandwich
		Using the tablet			Grasping and manipulating keys			Preparing sandwich
		Typing			Opening-closing locker (key)			Making salad
		Using the mouse of the PC			Introducing code in a device			Serving cake
d5	SELF-CARE				Handling bills and coins			Preparing & frying fish
	d510	Washing hands			Manipulating toys (Assembling)		d640	Clothes (washing machine)
		Taking a shower		d445	Pulling drawer			Taking out clothes (w/machine)
		Drying oneself			Pushing drawer			Washing dishes
	d520	Making up			Reaching sth from a shelf			Clearing the table
		Cream on hands			Throwing a ball			Sweeping
		Brushing teeth			Catching a ball			Ironing
		Combing			Opening/closing door (key)			Storing shopping items
		Nail polishing			Opening/closing door (handle)			Trash a paper
		Cutting toenails			Opening/closing emergency door			Folding clothes
	d530	Urinating			Opening/closing the boot			Placing wood (chimney)
		Defecating		d470	Lift		d650	Sewing
		Chanching sanitary napkin			Bus: Get a ticket			Cleaning furniture
		Chanching a tampon			Bus:Using transportation			Changing a lightbulb
	d540	Putting on a belt		d475	Driving a baby buggy			Plugging in appliances (PC)
		Putting on socks and shoes			Driving a wheelchair			Plugging in a toaster
		Taking off a shirt			Driving a car			Unplugging
		Taking off a jacket			Driving a car:Shift into gear			Changing batteries
		Taking off boots	d9	COMMUNITY, SOCIAL & CIVIC LIFE				Checking the oil
		Taking of shoes		d920	Playing cards			Pumping a tyre
		Hanging up clothes			Playing video-games			Folding a baby buggy
	d550	Eating a piece of toast			Playing chess			Folding a wheelchair
		Eating snacks			Playing dice			Taking care of plants
		Handling crockery & cutlery			Cutting with scissors			Taking care of animals
		Eating with a knife			Folding paper		d660	Washing a baby's hands
		Eating with a spoon			Gluing			Dressing a child
	d560	Opening a can			Channel hopping			Assisting child to move
		Opening a bottle tap			Playing DVD			Feeding a baby
		Drinking from a bottle						
		Drinking from a can						
		Serving and drinking water						
	d570	Healing a wound (Band-Aid)						
		Putting on and off glasses						
		Cleaning glasses						
		Blow your nose						

Figure 2.

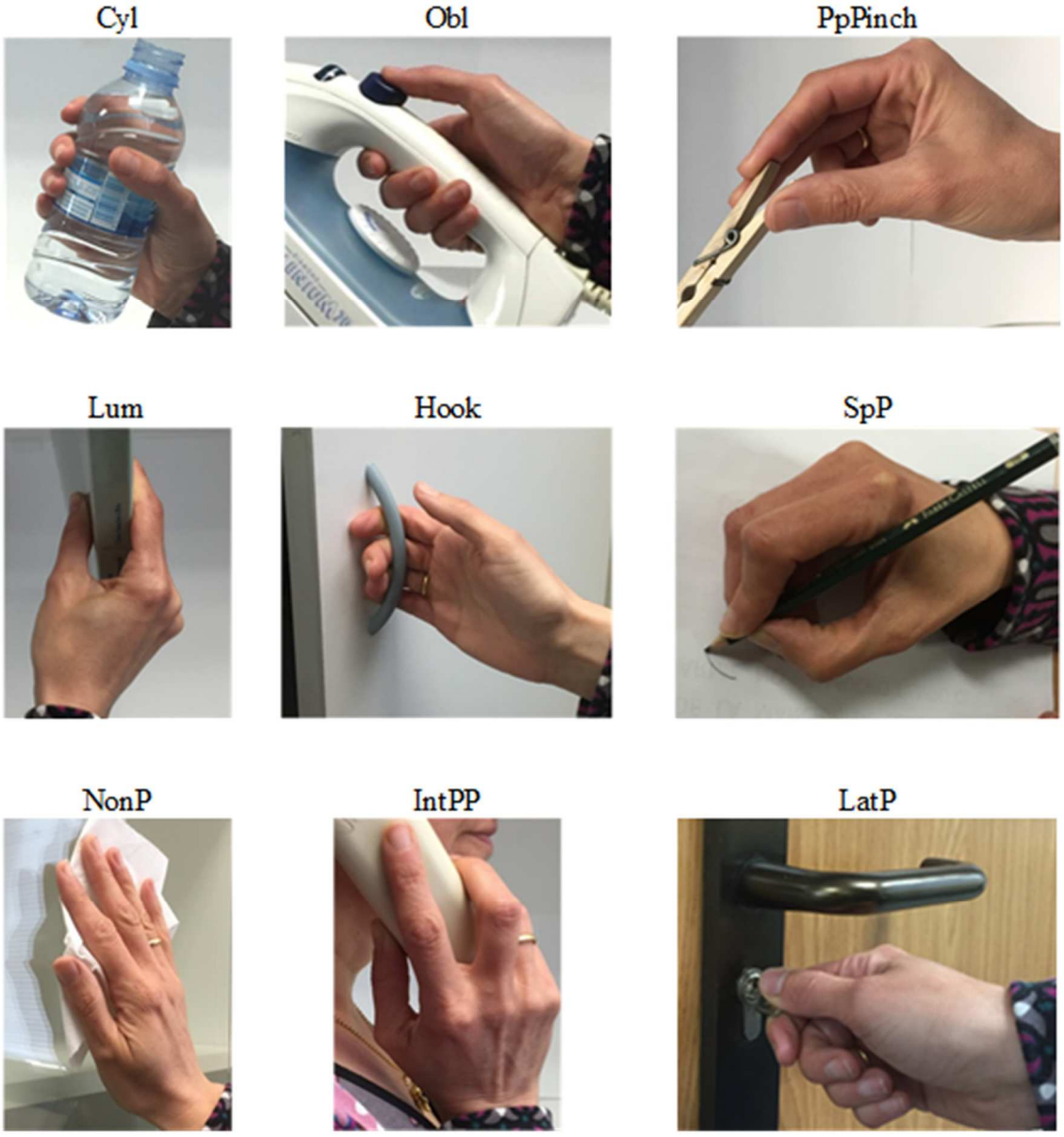


Figure 3.

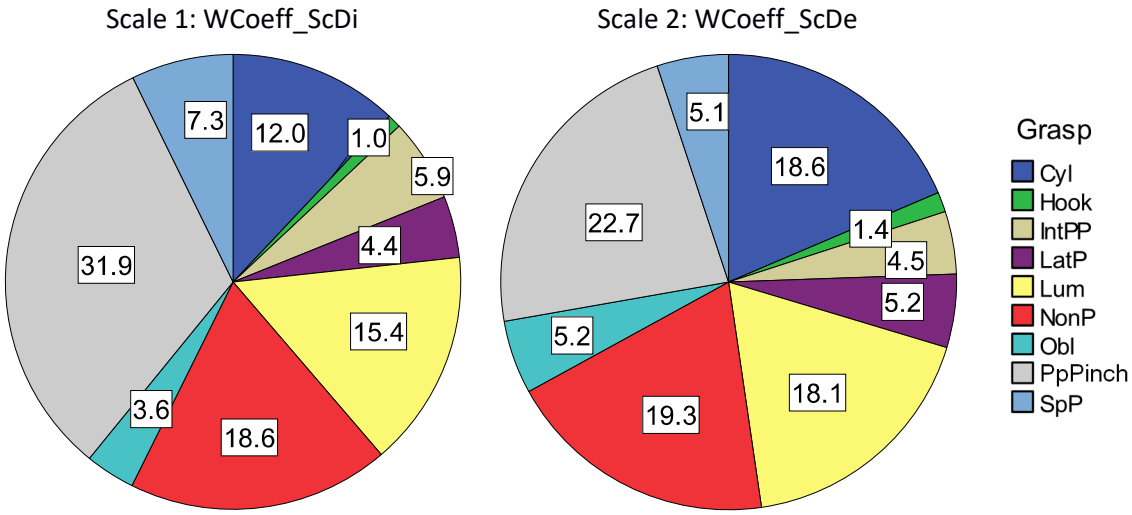

Scale 1: WCoeff_ScDi
7.3
12.0
1.0
5.9
4.4
31.9
15.4
3.6
18.6
Scale 2: WCoeff_ScDe
5.1
18.6
1.4
4.5
22.7
5.2
5.2
18.1
19.3
Grasp
Cyl
Hook
IntPP
LatP
Lum
NonP
Obl
PpPinch
SpP

Figure 4.

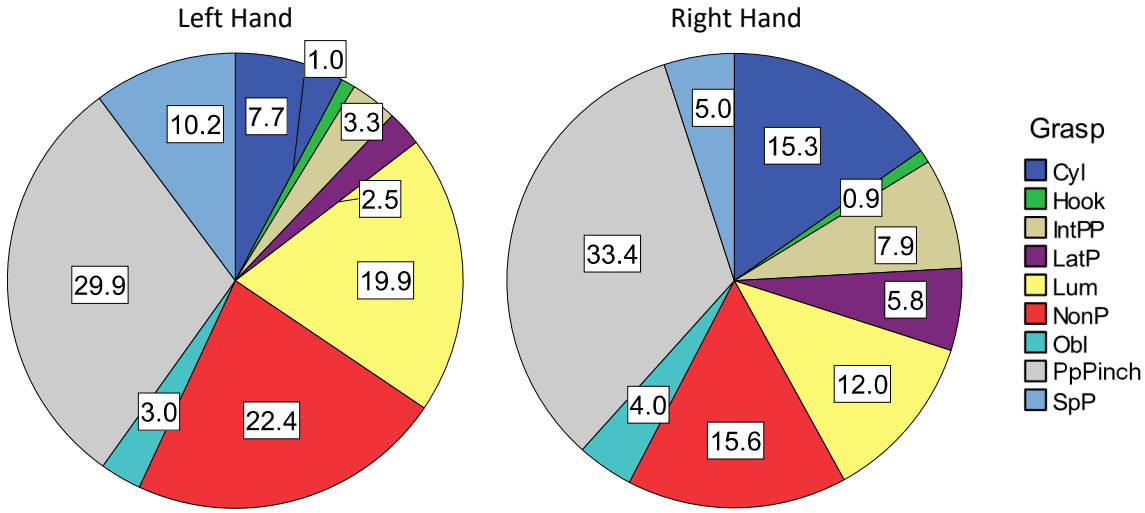
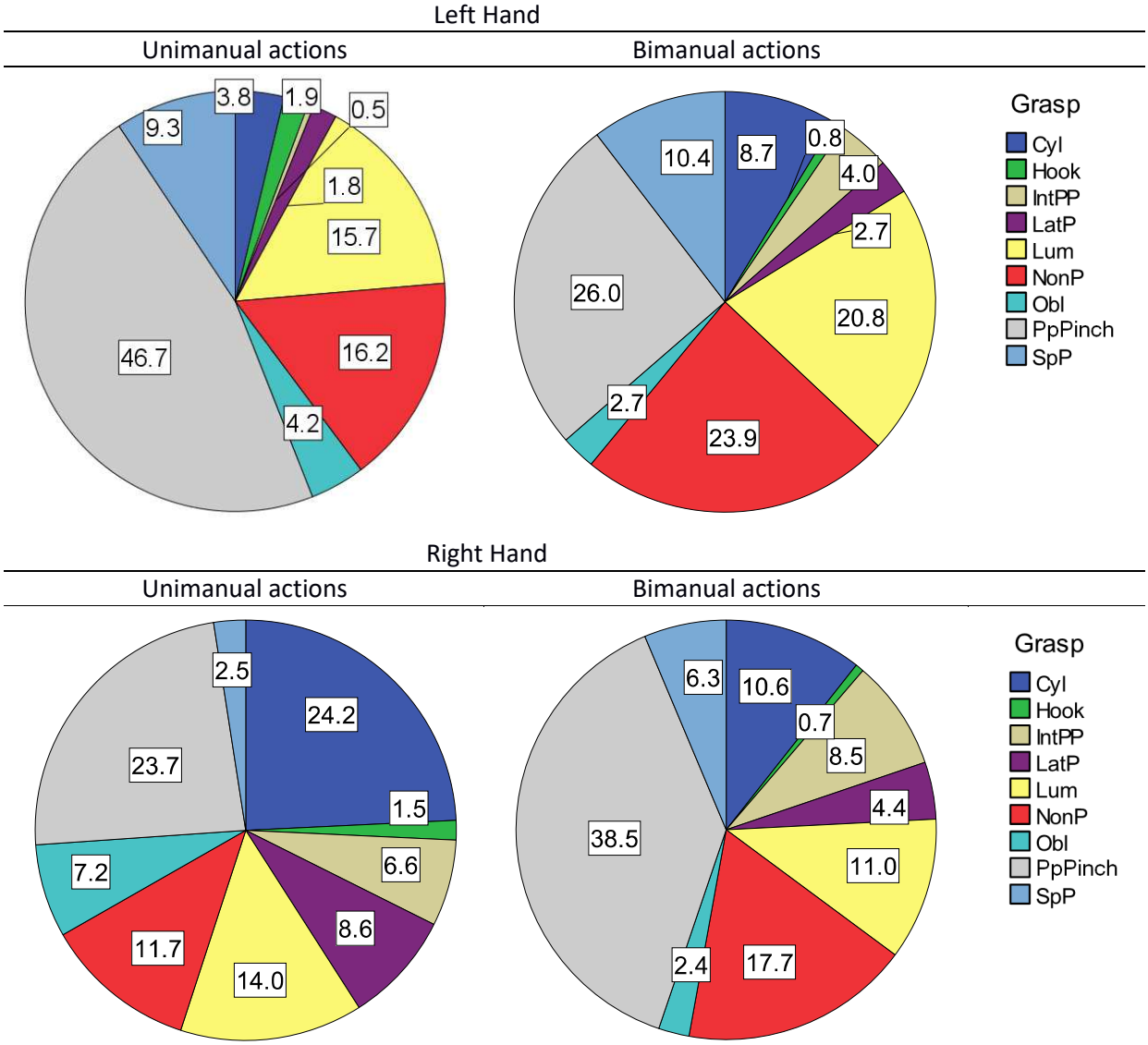

Left Hand
1.0
7.7
10.2
3.3
2.5
19.9
29.9
3.0
22.4
Right Hand
5.0
15.3
0.9
7.9
33.4
5.8
12.0
4.0
15.6
Grasp
Cyl
Hook
IntPP
LatP
Lum
NonP
Obl
PpPinch
SpP

Figure 5.


Left Hand
Unimanual actions
Bimanual actions
3.8
1.9
0.5
9.3
1.8
15.7
46.7
16.2
4.2
10.4
8.7
0.8
4.0
2.7
26.0
20.8
2.7
23.9
Grasp
Cyl
Hook
IntPP
LatP
Lum
NonP
Obl
PpPinch
SpP
Right Hand
Unimanual actions
Bimanual actions
2.5
24.2
23.7
1.5
7.2
6.6
8.6
11.7
14.0
6.3
10.6
0.7
8.5
4.4
38.5
11.0
2.4
17.7
Grasp
Cyl
Hook
IntPP
LatP
Lum
NonP
Obl
PpPinch
SpP