A study of the difficulties

disabled people

have when using everyday

consumer products.

GOVERNMENT CONSUMER SAFETY RESEARCH

dti

Department of Trade and Industry

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EXECUTIVE SUMMARY

The DTI Consumer Affairs Directorate have for many years been concerned with promoting "safety in the design" of consumer products to reduce accidental injuries. To-date the concern has been mainly with children, adults and older people. To assist designers to make products safer, the DTI commissioned the development of human factors data on these three groups within the general population. However, until now there has been no particular focus on the characteristics and capabilities of disabled people.

Whilst everyday consumer products are usually well designed for safe use by able-bodied people, some are not necessarily designed to suit all the needs of disabled people. This means that some consumer products cannot be used by disabled people, and others cannot be used as efficiently, which both inhibits business in meeting market expectations and consumers in having the widest possible choice. Therefore, the work we have called "Disabled Data" is aimed at developing new data to assist designers to develop everyday consumer products that can be used safely and efficiently by both able-bodied and as wide a range of disabled people as possible. This will be of benefit both to consumers in extending choice and to industry, as it will open up wider markets to the consumer products they supply. This work will help designers to fully take account of the special needs of disabled people, in particular, to make every day products easier to use.

This study aimed to identify the nature of the problems that disabled people have with consumer products and to determine what characteristics and capabilities should be measured. RFA, Consultants in Ergonomics and Design, conducted this study. It will be used to focus further research aimed at developing suitable strength, physical and cognitive data for use by designers.

A literature study demonstrated there was little evidence or data on the problems that disabled people have with consumer products. Methods for assessing the difficulties that disabled people have are frequently carried out by occupational therapists in order to assess the level of support required. These are called Activities of Daily Living assessments (ADL). Such assessments however take little heed of design deficiencies of products or environmental features. Unfortunately there is no generally accepted standardised method of ADL assessment, neither is there any normative data.

The literature survey did however identify a method of assessment developed in the US namely the Assessment of Motor and Process Skills (AMPS) which was well structured, was cross culturally sound and for which normative data existed. In principle, the AMPS approach was used for this study with certain adaptations to suit the study's specific aims. The method basically involved asking a disabled person to select three or four tasks from a wide selection of household activities essential to Daily Living. The tasks selected were those that offered a level of challenge i.e. not tasks that were considered very easy or very difficult. The ability to carry out the tasks and use the products inherent to those tasks was judged according to a number of motor and process skills on a five-point scale.

Disabled people were contacted throughout the Midlands. In all 218 people were visited and assessed using the modified AMPS assessment technique. The representivity of the sample was tested against the UK OPCS Survey of Disabled Adults in Britain carried out in 1989. This showed that all of the different functional groups were represented at all levels of severity giving a good representation of the whole of the UK. However, because the sample drew on people who had some difficulties with Daily Living, inevitably the sample in this study represented somewhat more severe functional groups than in the OPCS study. The age range of the sample was also compared with general statistics of the UK general population. This demonstrated that all ages in the range were represented with a tendency to over representation to the over 60 years of age. This arose because the majority of disabled people are over 60 years.

The analysis of the four tasks selected by the participants in the study demonstrated that they had difficulty in using many household products. The nature of these difficulties can best be described in terms of the factors used in the study to determine the nature of the difficulties experienced.

With regard to product *manipulation* those products that required a co-ordinated two-handed operation e.g. unscrewing a jam jar, were often found to be very difficult. In addition, coping with those products that required relatively high levels of force, combined with small or badly shaped operating features, were also found to be very difficult. Many examples were found in relation to packaging, whether grasping tabs or tearing package edges were found to cause many problems with people often having to resort to using knives or scissors.

Products that required high *gripping forces* because of their weight, or the position of their centre of gravity, also created problems. This was particularly true when the gripping parts were poorly designed. An example of such products were teapots and grill trays.

Lifting products that were heavy or unwieldy created many difficulties. This was exacerbated when handles or grips were poorly designed or inconveniently located on the product. A good example of this that many people found difficulty with was vacuum cleaners.

Products often have to be *transported* from one location to another and often from one height to another. Where objects, such as buckets, were heavy and needed to be carried with a space between them and the body, serious problems were observed. Again, parts which were inappropriately designed or missing were part of the problem.

The following product types and groupings represent everyday activities that all people have to do during a normal day. The data collected show the level of difficulty for disabled people in completing these everyday activities. The list of seventy-two products that were used in the study was categorised into three groups, namely packaging products, products incorporating handles and products with controls. The products in these three categories

Note: OPCS is now part of the Office of National Statistics (ONS)

were then ordered in terms of difficulty of use, and common factors between the worst products were summarised to give recommendations for design improvements and suggestions for the measures that are to be made in the next phase of the study.

Part of the survey also collected simple 'yes' / 'no' data on the ability of the participants to carry out those tasks that were not selected from the full list offered. The results from this part of the survey produced a list of tasks in order of difficulty that was compared with the AMPS task difficulty order. A good correlation was demonstrated between the two.

A third part of the study was to ask participants which, if any, other tasks generally considered very difficult or impossible for disabled people to carry out, and which were not included in the list of household tasks referred to previously. These tasks included D.I.Y. and gardening tasks and those tasks where an obvious safety component was evident. Examples of such tasks are mowing the lawn, using a ladder, or changing a light bulb. The results of this approach showed that the product that performed the best in this list of gardening and D.I.Y. products could only be used by less than fifty percent of the participants.

In conclusion, the detailed analysis of the problems participants had with those tasks and products selected for assessment gave a clear indication of the nature and type of functional demands such products make on disabled people. As a result of this analysis the characteristics and capabilities of disabled people that need to be measured was identified. The collection of such data for a wide sample of disabled people will provide information those designers need in attempts to design products that are safe and easy to use by disabled people and indeed the general population.

INTRODUCTION

The DTI Consumer Affairs Directorate have, for many years, been concerned with promoting "safety in the design" of consumer products in order to reduce accidental injuries. To-date the concern has been mainly with children, adults and the elderly population. To assist designers to make products safer, the DTI commissioned the development of human factors data on these three groups within the general population. However, until now there has been no particular focus on the characteristics and capabilities of disabled people.

Whilst everyday consumer products are usually well designed for safe use by able-bodied people, some are not necessarily designed to suit all the special needs of disabled people. This means that some consumer products cannot be used by disabled people, and others cannot be used as efficiently, which both inhibits business in meeting market expectations and consumers in having the widest possible choice. Therefore, the work we have called "Disabled Data" is aimed at developing new data to assist designers to develop everyday consumer products that can be used safely and efficiently by both able-bodied and as wide a range of disabled people as possible. This will be of benefit both to consumers in extending choice and to industry, as it will open up wider markets to the consumer products they supply. This work will help designers to fully take account of the special needs of disabled people, in particular, to make every day products easier to use.

This study aimed to identify the nature of the problems that disabled people have with consumer products and to determine what characteristics and capabilities should be measured. RFA, Consultants in Ergonomics and Design, conducted this study. It will be used to focus further research aimed at developing suitable strength, physical and cognitive data for use by designers.

2.0 LITERATURE REVIEW

2.1 Background

A survey of the literature was performed to identify reports concerned with the use of consumer products by disabled people. The following databases were searched:

- BioMedNet
- BIDS ISI Citation Indexes
- Ergonomics Abstracts

Problems with consumer product use appear to be commonplace, from difficulties associated with the manipulation of consumer product controls to understanding the processes needed to operate electronic equipment. It would seem reasonable to assume that these problems are exacerbated among the disabled. However, there has been little information published about disabled people's specific difficulties with different types of product (with the exception of those which can be considered architectural) and the potential safety hazards that certain products may cause them.

2.2 Home Accident Surveillance System

The Home Accident Surveillance System (HASS) report (Department of Trade and Industry, 1998) contains the latest available statistics on home and leisure accidents in the UK. The report lists the number of accidents involved with consumer products over a period of twelve months (beginning in January 1996) from a representative sample of Accident and Emergency Units and provides national estimates. One of the major aims of the HASS report was:

"…to give businesses information to modify the design of products to reduce and eliminate injuries caused by careless use." (Department of Trade and Industry, 1998, p1)

The information in the HASS report allowed the identification of a range of relevant key products, which were associated with a large number of accidents in the home. These key products were arranged into hierarchical order of their potential to be involved in accidents. No specific literature was identified in relation to accidents with consumer products and disabled people.

2.3 Activities of Daily Living

The use of consumer products in the home has a clear and close link with 'Activities of Daily Living' (ADL). ADL is an occupational therapy term, involved with the assessment of a person's ability to carry out everyday tasks, mainly as an instrument of the level of support needed and to assess the effect of intervention procedures over time. The search of the databases, looking for potential links between these two areas, met with limited success.

While there was a considerable number of published works regarding ADL, it was not felt that enough of these could be extrapolated to disabled people and their problems with consumer product use.

Occupational therapists routinely evaluate ADL by direct observation, however, the majority use 'home-grown' evaluation tools without knowledge of validity or reliability. According to Fisher (1997, p12) "many programs have developed their own ADL assessments without adequate attempts to establish the validity and reliability of the instruments", leading to a lack of a "gold standard" instrument.

The Institute of Occupational Therapy uses two methods in their assessment of ADL. The first 'BARTEL', was not considered to be useful in aiding the project's investigation, on the advice of the Institute of Occupational Therapy, who recommended the second method 'the Assessment of Motor and Process Skills' (AMPS). Whilst this is basically a method of assessing ability in relation to ADL, it was felt that its basic principles and methodology could be used to assess the difficulties that disabled people have with consumer products and to identify related functional issues.

2.4 The Assessment of Motor and Process Skills

AMPS (Fisher, 1997) is a test of disability and an occupational therapy measure of a person's ability to live independently. It is not a test of impairments or capacity to do a task, but a test of disability and how effectively a task can be done. Capacities pertain to strength, range of motion, memory and cognition. However, AMPS evaluates whether any existing impairment has impacted learned motor and process skills. The AMPS was developed as an observational measure to overcome limitations of other ADL measurements, associated with self-reports and proxy reports (Doble, Fisk, Fisher, Ritvo and Murray, 1994).

It involves the assessment of a range of both motor and process skills, while performing a number of ADL tasks. The AMPS is used to measure person's quality of ADL performance, which is rated in terms of the effectiveness, efficiency or safety of component actions that the person uses in ADL tasks. These tasks involve a range of consumer products (including many of those identified in the HASS report) and vary in difficulty. These tasks, covering personal activities of Daily Living (PADL) and instrumental activities of Daily Living (IADL), all involve product use to some extent.

The AMPS method measures motor skills in the sense of those skills that are:

"…the observable component actions the person uses during the performance of ADL tasks in order to move oneself or the task objects." (Fisher, 1997, p149)

There are sixteen of these motor skills that are rated in AMPS testing. These are *stabilises, aligns, positions, walks, reaches, bends, co-ordinates, manipulates, flows, moves, transports,*

lifts, calibrates, grips, endures and *paces.* They are seen as being related to underlying postural control, mobility, co-ordination and strength.

The measured process skills are defined as:

"…the observable actions of performance that reflect the person's ability to logically sequence the actions of the ADL task performance over time, select and use appropriate tools and materials, and adapt his or her performance when problems are encountered." (Fisher, 1997, p4)

There are twenty process skills that are rated during an AMPS assessment. These are *paces, attends, chooses, uses, handles, heeds, inquires, initiates, continues, sequences, terminates, searches/locates, gathers, organises, restores, navigates, notices/responds, accommodates, adjusts* and *benefits.* Like AMPS motor skill items, the process skill items represent a universal taxonomy of actions that can be observed during any task performance (Park, Fisher and Velozo, 1994). The AMPS motor and process skills are considered to be universal because "no matter what tasks a person performs, he or she must *reach* for and *lift* task objects, logically *sequence* the steps of the task, and so on" (Goldman and Fisher, 1997, p78).

2.4.1 AMPS tasks

AMPS uses a list of over sixty ADL tasks, which are ranked in a hierarchy of difficulty on both a motor scale and a process scale. That is, the tasks are conceptualised as being positioned on two lines, one representing ADL motor ability based on the level of challenge, the other representing ADL process ability based on the level of challenge (Fisher, 1993). For example, 'eating a meal' is seen as a very easy task in terms of motor skills, while 'vacuuming' is seen as very difficult. 'Putting on socks and shoes (tied)' is seen as a very easy task in terms of process skills, while 'preparing egg, toast and espresso coffee' is seen as very difficult.

The 2 or 3 ADL tasks that the subject is to perform, during an AMPS assessment, are chosen beforehand, by means of an interview. The goal of the interview is to narrow down the tasks into those that the subject actually does perform in his or her home but at the same time trying to choose tasks which he or she does not find easy. Once the tasks have been sufficiently narrowed down, the interviewer gives the subject a list of 5 or 6 tasks, from which he or she must choose 2 or 3 to perform. This is done as both younger and older adults have been found to have improved process performance when given their choice of tasks (Dickerson and Fisher, 1997).

"The AMPS is designed to allow the person evaluated to choose what ADL tasks he or she will perform for the evaluation based on (a) the familiarity and relevance of the tasks to the client's daily life needs, and (b) the degree of challenge that the tasks offer the client… task

performance is maximised when an individual has the opportunity to choose and enter into task performances that match the individual's volitional traits." (Fisher, 1997, p7)

2.4.2 AMPS scoring

During each task performed for the assessment, the person was rated on a four-point scale (1 = Competent, 2 = Ineffective, 3 = Questionable, 4 = Deficit) for each of the sixteen motor and twenty process skill items. The skill items for each task were rated by a clinician who observes the subject's performance of each task. The clinician observes, during the actual task performance, which motor and process skills the person possesses that support his or her task performance and which skills the person lacks that impede his or her performance. Therefore, the clinician is able to measure directly why ADL task performance may be difficult for the person (Park, Fisher and Velozo, 1994). Unlike other ADL assessments, the AMPS can be used to clarify the relationship between specific skill deficits and global functional performance (Fisher, 1997).

2.4.3 AMPS analysis

The results from the observations of the ADL tasks are analysed by a many-faceted Rasch analysis computer programme. This places the person on a line representing the variable item difficulties and the group of people who vary in ability. Four facets are calibrated simultaneously on the same linear scale for both AMPS motor and AMPS process scales:

- skill item easiness
- task simplicity
- rater leniency
- person ability

(Fisher, 1993)

The inclusion of 'rater leniency' as a facet for analysis is based on the awareness that rater training serves to direct the attention of the raters, as opposed to controlling the leniency of their assessments. However, it has been observed that while the severity of scoring varies among raters, the leniency of the individual rater remains stable (Lunz and Stahl, 1990). For AMPS, a performance evaluation was developed, based on the observation of the raters' scoring of task performance, each rater is given a score on a scale of leniency/severity of their scoring of people's ADL task performance. This enabled occupational therapists to account for differences in rater leniency in the scoring of the person's ability measures (Fisher, 1993).

Therefore when the Rasch (1993) analysis was completed, a subject was placed on the uni-dimensional motor skill or process skill scale, and it can be predicted whether a person possessed the motor or process ability to perform tasks that are more difficult than those the person was observed performing.

2.4.4 AMPS validity

There is no reported overall significant difference between AMPS motor ability measures in a home setting and in a clinic setting. However, a number of studies have found a significant difference in AMPS process ability measures between the home setting and clinic setting. Process ability in the clinic underestimates process ability in the home. The AMPS ADL process skills scale is said to be a more sensitive measure of the ability to live independently in the community than the AMPS ADL motor skills scale. The abilities searches/locates, notices, handles, accommodates and benefits appear to be affected more, in this way, than other process skill items (Park, Fisher and Velozo, 1994).

The motor and process skill items and tasks defined in the AMPS have been verified as cross-culturally free from bias between North America, Scandinavia and the United Kingdom. Other research has found that the AMPS is valid for use across gender subgroups. Men and women do not differ in AMPS motor ability, but women are slightly more able in AMPS process ability (Duran and Fisher, 1996). The AMPS has been fully standardised, internationally and cross-culturally on approximately 35, 000 subjects.

"The AMPS provides occupational therapists with a powerful and sensitive tool that can assist with planning effective interventions and documented change. The AMPS, therefore, also is an ideal tool for use in outcomes research." (Fisher, 1997)

METHODOLOGY

3.1 Background, modifications to the AMPS system

3.1.1 General requirements

In adapting and integrating AMPS components into the RFA survey there were a number of general requirements. These were as follows :

- to retain the idea of scoring on the differentiated motor and process skill items.
- to adapt the AMPS scoring technique in order to make the consumer products (and the disabled person's interaction with specific products) the focus of data recording
- to exploit the AMPS hierarchical list of tasks based on task difficulty
- to select tasks on the basis of what the participant can do, albeit with difficulty

3.1.1.1 Motor and process skills and product orientated rather than user orientated scoring

The major AMPS principle of scoring on both motor and process skill items was retained in the RFA questionnaire as a major factor in identifying the functional demands in product use. Participants for the study were selected on the basis that they were capable of living independently. By definition this meant that the participants had little or no process problems. The process factors were therefore retained to confirm that the participants were capable of living independently, and to determine if any product caused significant process problems due to specific design features.

To reflect the need for this type of data, the RFA survey questionnaire incorporated scoring sheets for each product used during the overall task. AMPS motor and process skill items that could be extrapolated to product use were kept, while others, of less relevance to product use, were discarded. The motor skill items retained were *manipulate, lift, grip, transport* and *reach* (for definitions, see section 3.2.8). The process skill items retained were *sequences, notices, uses,* and *terminates.* The use of each product in each task was scored on these nine skill items. Additionally, process skills for the entire task performances were scored on the items *gathers, organises, uses, notices/responds* and *terminates.*

3.1.1.2 Scoring scale

The four point AMPS scoring scale (1= competent, 2 = ineffective, 3 = questionable, 4 = deficit) was not felt to be sufficient to rate the skill items regarding product use or overall task process. This was determined through the piloting of the questionnaire. It was concluded from this that there was a need to have an additional point on the scale namely, 'completed, but with difficulty'. Therefore the AMPS scale was expanded upon, to reflect the needs of the RFA survey, creating a new five point rating scale as follows:

1= competent

2 = adequate – with some difficulty

3 = adequate with much difficulty

4 = ineffective

5 = deficit

3.1.1.3 Selection of tasks

A revised list of tasks was drawn up, incorporating many AMPS tasks and keeping a range of both motor and process difficulty. Package opening, which was not included in the AMP set of tasks, was incorporated in to the RFA list of tasks as this was considered to be a major aspect in product interaction. In general, the AMPS tasks were changed to emphasise the manner in which the subjects used the products. The AMPS interviews are performed on the basis of an interviewer describing a task that is to be performed by the participant with little or no intervention. Since, in the RFA study, the emphasis was on products, the tasks that were performed were broken down into a number of key stages in order to allow the participant - product interaction to be recorded.

As in AMPS, the interviewers and the subjects decided on the tasks to be performed on the basis that the tasks should not be easy for the subjects to accomplish but equally should be tasks that subject can and does do. Four tasks were selected wherever possible. Some participants however were only able to perform three of the listed tasks, and some participants who selected four tasks only managed three due to fatigue.

3.2 Interview procedure and the assessment questionnaire

3.2.1 Introduction

The following describes the interview procedure and the questionnaire that was designed on the basis of the AMPS system as described above. The questionnaire was broken down into a number of different sections. These sections are briefly described below.

3.2.2 OPCS assessment

Studies by the Office of Population Censuses and Surveys (Martin et al, 1988) reported on the prevalence and severity of disability amongst adults in England and Wales. The results described the number of adults with disabilities and rated the severity of each person's disability. Disability was classed into 13 distinct categories, namely :

- locomotion
- reaching and stretching
- dexterity
- seeing
- hearing
- personal care
- disfigurement
- continence
- communication
- behavioural
- intellectual functioning
- consciousness
- eating, drinking, digesting

A severity rating was used that categorised each individual according to 10 categories of equal width in terms of severity. Category 10 contained the most severely disabled people and category 1, the least disabled. The higher the severity rating therefore, the more severely effected the person was by their disability.

3.2.3 Tasks

In this section of the questionnaire, the tasks to be carried out by the participant were confirmed. These tasks would have been selected prior to the interview and agreed with the participant. The tasks were selected from a set of 24 tasks, largely based on those included in the AMPS assessment. Further tasks, not included in the AMPS tasks, were included to more closely reflect important products used in the home, such as microwaves, video recorders and televisions. These 24 tasks were also selected on the basis that they involved the use of products in the home and reflected many of the products, which are associated with accidents.

3.2.4 Task stages

The questionnaire included a task sheet for each of the four tasks selected. The purpose of these task sheets was to record the performance of the participant in each of the tasks as they were being carried out. Each task sheet has the following sections;

- brief
- assumptions
- task elements (products)
- assumed task stages
- task process

3.2.4.1 Brief

The brief was a precise description of the relevant task that the participant would carry out. The brief would be read out to the participant, prior to carrying out the task. Part of the assessment was scoring the ability of the participant to understand and carry out the task.

3.2.3.2 Assumptions

This part of the questionnaire listed the assumptions that were made about how the subject was expected to carry out the task in the assumed task stages (see Section 3.2.3.4). Any differences in the actual performance of the task compared with the assumed way the task would be performed, was noted in the appropriate task stage box.

3.2.3.3 Task elements (products)

This part of the questionnaire listed the products that it was assumed would be used in the task. A 'product sheet' is included for each of the products. Sheets are also included for any other products that are used in the task. The purpose of the product sheet is to rate the performance of the participant when using each of the products within the task. The assessment tool comprises a set of motor and process factors described below.

3.2.3.4 Assumed task stages

This was a breakdown of the task into stages that it was assumed would take place. Each stage has two tick boxes, to note if the subject needed verbal or physical assistance in the task, and a comment box to record coping strategies, any differences from the assumptions and safety implications.

3.2.5 Coping strategies

This section allowed a record to be made of any coping strategies used by the participant. Coping strategies refer to practices by the subject to help perform a task, which non-disabled people would typically not have to do. For example, a common coping strategy used by the disabled was to slide heavy objects (such as kettles full with water, saucepans full of food etc.) along work surfaces, or to lean on surfaces when using products (for example, as when leaning on the sink while filling the kettle or leaning against the washbasin while brushing teeth). There is an extremely wide range of these strategies and which may also include using extra items to help cope, or find other ways to complete the task. All of these strategies were recorded in the comment box at the appropriate stage of the task. These comments have been illustrated and utilised in the analysis process in Appendix 10, which identifies the worst products found in the survey in terms of disabled persons use.

3.2.6 Differences to assumptions

Differences to assumptions refer to any differences to the noted assumptions that the subject showed when performing the task. For example, the participant may have used different products, or performed the task stages in a different order. Any such differences were noted in the appropriate comment box.

3.2.7 Safety implications

A safety implication refers to any behaviour by the subject, during the task, which was considered to be unsafe or potential causes of accidents. Such behaviour was recorded.

3.2.8 Task motor and process factors

This part of the questionnaire assessed on a 5-point scale the various motor and process factors that were relevant in the use of products within the task. The process skills that were required for the completion of the whole task, for example, the ability to organise the various components of the task, were also rated.

3.2.8.1 The five point rating scale for process and motor factors

For each of the motor and process factors described below, a score was given on a scale that has been derived from the AMPS rating scale as described above. The scale components were;

1 = competent

2 = adequate – some difficulty

3 = adequate – much difficulty

4 = ineffective

5 = deficit

For each of the motor and process factors, described in the next section, definitions for all of the above ratings were developed and documented for the interviewers. This was to ensure consistency between interviewers in the rating.

3.2.8.2 Motor factors

Each of the motor factors described below refers to an aspect of product usage.

Manipulates
The use of controls mainly relating to fine hand and finger operations e.g. turning cooker controls, using a remote control, using microwave controls.

Lift
Lifting objects such as kettles, packaging etc without ambulating; pertains to having enough strength to lift objects.

Grips
Pinches and grasps in order to grasp handles, to open fastenings and containers, or to remove coverings; relates to effectiveness of pinch and grip (strength).

Transports
Carries objects while ambulating or moving from one place to another (eg in a wheelchair) pertains to the physical capacity to gather.

Reaches
Stretching or extending the arm, and, when appropriate, the trunk to grasp or place the objects that were out of reach. Pertains to the ability to effectively reach to the extent necessary in order to obtain objects.

3.2.8.3 Process factors

Five process skills were rated on this scale on the task sheets in order to rate the cognitive abilities of the participants in completing the overall task. These process headings are described below.

Gather
Gathers - refers to gathering appropriate items needed for the task without forgetting or misplacing them.

Organises
Organises - refers to laying out the items, as defined by the task sheets, in a logical fashion. For example, placing all the appropriate items on a single work surface for ease of use.

Uses
Uses - refers to the ability to understand and use the appropriate items in the correct manner.

Notices/responds
Notices/responds - refers to noticing and responding to feedback from the products involved in the task, eg noticing the light on an iron indicating a temperature has been reached and responding by beginning ironing.

Terminates
Terminates - refers to the subject understanding that the task is complete.

3.3 General methodology

A number of stages were involved in the survey. These were:

- identify sampling frame
- locating potential participants
- telephone interview
- confirmation letter
- interview and assessment

Each of these stages is now dealt with separately.

3.3.1 Identify sampling frame

The sample for the survey was selected on the basis of the OPCS distribution (see above). The sample, in general, provided a distribution of participants with different levels of severity, according to the OPCS categories. The basic functional groups are shown below:

- wheelchair users (65 manual wheelchair users and 65 electric wheelchair users)
- ambulant disabled people
- visually impaired participants
- hearing impaired participants

3.3.2 Locating potential participants

The RFA database of participants who have taken part in various studies over the past three years yielded approximately 100 disabled people who would be eligible for the research. The remainder of the required sample (250 participants) was sourced from the following organisations:

- the wheelchair users association of Coventry provided a sample of 60 indoor electric wheelchair users, 60 manual users, and 60 ambulant users who use wheelchairs when outdoors
- Derby Health Authority day centres provided a sample of 60 ambulant users
- Leicester Health Authority provided a sample of 10 wheelchair users and 10 ambulant users
- Leicester Society for the Blind provided a sample of 20 partially sighted people
- Leicester Guild for the Disabled provided a sample of 20 hearing impaired and deaf people

From the above, it was estimated that the full number of participants ie 250 were available for the survey.

3.3.3 Telephone interview

The telephone interview was used to establish a number of criteria relating to the capabilities of the disabled person. The OPCS severity scoring system was used to establish the motor skills (locomotion, manual dexterity, reaching and stretching) that are affected by the participant's disability. This is then used as the basis for the selection of four tasks from a battery of twenty-four tasks that have been established using the AMPS system as discussed earlier. Some of the tasks require preparation by the participant. For example, the task relating to the use of the washing machine requires the participant to have washed a load of washing. This was done in order to examine the task of unloading the heavy wet washing from the machine. Such preparation was agreed with the participant. The telephone interview also provided the opportunity to arrange a date and time for a visit.

3.3.4 Confirmation letter

A letter giving the date and time of the interview was sent to the participants. In addition, the preparation tasks that were agreed in the telephone interview were re-iterated. A digitised picture of the interviewer, and a code number, was included in the letter for the increased security of the participant.

3.3.5 Interview and assessment

At the start of the interview, the tasks previously selected in the telephone interview were confirmed with the participant. The OPCS rating scale was then administered, and the participant then went through each of the four tasks that had been previously agreed, and the assessment carried out as described above.

4.0 RESULTS

4.1 Introduction

The following section presents the results that were found in the study. The following information is included:

Information relating to the viability of the sample and the tasks that were selected by the participants.

- viability of the sample used in the study
- the tasks that were selected by the participants from the list of 24 for the interview, and the tasks that were or were not possible from the remainder
- subjective assessment of the ability to carry out DIY type tasks

Information relating to the specific products used in the task

- The products listed in order of difficulty of use in terms of four motor factors *manipulating, lifting, gripping* and *transporting,* and categorised in terms of packaging products, products that incorporate handles and products that incorporate controls
- the eighteen products that cause most difficulty for the participants
- the relationship between age and difficulty with different products/tasks

4.2 Viability of the sample used in the study

4.2.1 Comparison of the composition of RFA sample with OPCS sample

Although this survey has certain deficiencies when comparing the distribution of impairments and severity of impairment, with the RFA sample, it is the only generally available data on disabled people in the UK. The OPCS survey results were chosen as a sampling frame for this research.

In order to use this as a sampling frame it was necessary to administer the same severity questionnaire used by the OPCS, to each participant in the RFA study. However, for the purpose of this study, the severity questionnaire was only applied across the categories, which would have a direct relationship with participant's abilities to use consumer products. These were: Locomotion, Reaching / Stretching, Dexterity, Vision and Hearing. A copy of the severity questionnaire is included in Appendix 1.

The results from the RFA study together with those from the OPCS are shown in Appendix 2. The charts show that although each category in terms of the distribution of severity did not exactly match those in the OPCS study, nevertheless all categories were well represented. The main differences were that the RFA sample was over-represented in terms of those with greater severity in the Locomotion category. The high number of wheelchair users in the RFA sample exemplified this. This was also true for the Dexterity category.

The decision to over represent in the locomotion and dexterity factors was taken at the start of the project in order to explore the areas in which disabled people would have most problems in terms of product interaction. If a fully representative sample had been interviewed there would be less information on the products and product interactions that caused problems for disabled people. With Hearing, the sample was also more skewed towards the more severely impaired.

4.2.2 Comparison of the composition of AMPS sample with OPCS sample

Use of data from the AMPS database was contingent on that database being representative of disabled people in the UK.

While it would have been useful to directly compare the AMPS with the OPCS sample in terms of the categories represented and the severity rating, this was not possible since the AMPS sample did not use any severity rating comparable to the OPCS study. It was hypothesised that if it could be shown that the basis for the AMPS sample was comparable to that of the RFA sample then it could be assumed that the representivity of the AMPS sample was comparable with the OPCS sample.

The AMPS study gave results rated according to disabled people's ability to carry out chosen tasks related to Daily Living. These were selected from a list of over 50 tasks according to the disabled person's preference. The AMPS list of tasks is shown in order of difficulty based on the abilities of a large sample of people. From the results of the RFA study, the tasks similarly chosen by participants can also be ordered in terms of difficulty.

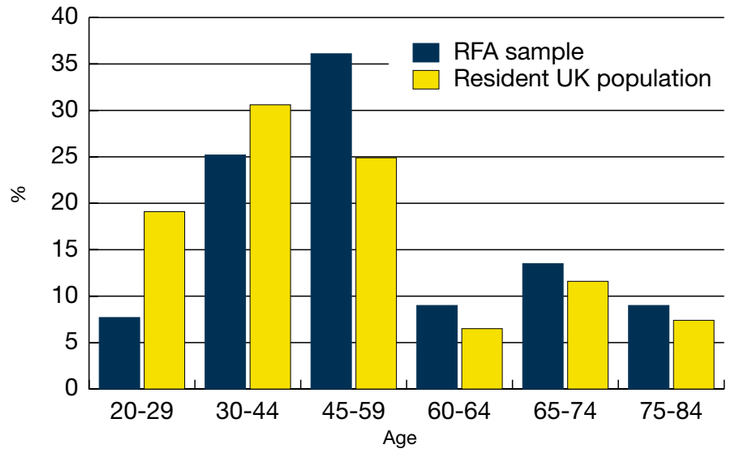
The order of the AMPS task difficulty list was then compared with that of the RFA list. The results are shown in Appendix 3.

The results show a strong correlation (0.75 at the 0.01 level of significance with the threshold for significance being above 0.467) between the task order that was demonstrated by the RFA study and the order produced by the AMPS process. This supports the conclusion that the modified AMPS approach used in the RFA study was valid because the order of task difficulty was significantly similar. In order to verify the approach that was used by the RFA interviewers a trained AMPS interviewer accompanied the RFA interviewers on 30 interviews. The RFA method did differ from the AMPS method of data collection due to the need to assess the products being used and not the incidence of the person as is the case with AMPS. The main difference was that participants were allowed to describe the problem that they were having, and explain any coping strategies that they were using. This is not allowed in the AMPS method due to the need to measure the person's cognitive (process) abilities.

4.2.3 Age range of the sample

The ages recorded in the RFA sample are shown below in comparison to the data from the UK Annual Abstract of Statistics (1999).

A comparison between the age range of the RFA sample and the age range of the resident general population (UK Annual abstracts of Statistics)



Age	20-29	30-44	45-59	60-64	65-74	75-84
RFA sample (%)	7.7	25.2	36.1	9.0	13.5	9.0
Resident UK population (%)	19.1	30.6	24.9	6.5	11.6	7.4
Difference (%)	-11.4	-5.4	11.2	2.6	1.9	1.7

The graph and table above show a comparison between the age range of the RFA sample and the age range of the resident general population as of 1997. The graph and table show an under representation of the 20-29 and 30-44 age groups, combined with an over representation of the 45-59 age group by the RFA sample. The age groups encompassing the 60 – 84 ranges are well represented. The participants were selected on their disability level, not their age. The skewing of the RFA sample towards the older population is explained due to the higher prevalence of disability among elderly people.

4.2.4 Sample composition

The number interviewed was 218. The disabilities represented in the sample in terms of the functional category and in terms of severity within each category are shown, as previously mentioned, in Appendix 1.

The original anticipated structure for the RFA sample is shown below and is compared with the structure achieved.

	Anticipated sample structure	Sample structure for the first 194 participants
wheelchair users	130	95
ambulant disabled	130	71
visually impaired	20	40
hearing impaired	20	32

Many of the participants were included in two or more of the categories above (e.g. wheelchair users with a visual impairment). This accounts for the categories totalling more than the sample actually interviewed.

4.3 The tasks and the difficulties participants experienced

In determining the ability of participants in the sample to carry out every day household tasks involving consumer products, three different approaches were used as described below:

- The main approach was to present a list of 24 tasks to each participant from which 4 tasks were selected (as described earlier). The basis for each participant selecting tasks was that they should be able to complete the tasks but that they should not be too easy or too difficult.
- A second approach was to ask participants using a simple ‘yes’ or ‘no’ choice, whether they were able to carry out any of the remaining 21 tasks.
- A third approach was to ask which if any, other tasks generally considered very difficult or impossible for disabled people to carry out, and which were not included in the 24 tasks referred to previously. These tasks included DIY and gardening tasks and those tasks where an obvious safety component was evident. Examples of such tasks are mowing the lawn, using a ladder or changing a light bulb. Unfortunately, inclusion of this latter approach was decided late in the study and therefore the sample size was 48 ie approximately 25% of the total sample.

These three approaches are now dealt with separately.

4.3.1 The four tasks selected by participants

The results from the tasks selected and carried out by the participants in the study are shown in Appendix 4. The tasks selected by the participants in the study varied according to each participant’s ability. It was initially expected that the number of instances of task performance would reduce with increased task difficulty ie the easier tasks would be more likely to be selected by the participants. This was shown not to be the case by performing a correlation between the tasks in order of difficulty and the number of instances that each task was performed. The anticipated negative correlation was found but not to a significant level. This can be explained as follows:

- People genuinely tried to select a task that they found challenging. This was supported by a number of examples. One such example was the selection of the task 'vacuuming the floor'. Around 75% of the participants (n = 163) stated that they would not be able to use a vacuum cleaner. However, of the remaining 25% (n = 54), 98% elected to perform the vacuuming task.
- Some tasks are essential to every day living and therefore people need to come to terms with the products involved and adopt coping strategies in order to complete the task. This is emphasised by the task of vacuuming the floor which was one of the hardest tasks in both the RFA and AMPS task ordering, and yet was performed the most.

4.3.2 Subjective assessment of ability to carry out the 21 remaining tasks

The graph in Appendix 4 shows the results of the participants stating ability to carry out the 24 tasks with which they were presented. The table in Appendix 5 shows the tasks ordered in terms of the ability to carry out the task. This produces a list of perceived task difficulty that can be compared to the task order of difficulty provided by the AMPS system as described above in Section 4.2.2.

It was clear that the tasks which involved gross hand and arm movements and which also involved a certain degree of strength, were the ones that created most difficulty. These included tasks such as vacuuming the floor, ironing an item of clothing or changing a bed. Conversely, tasks that were relatively 'light' and did not involve gross movement or high strength presented the least difficulty.

4.3.3 Subjective assessment of the ability to carry out DIY type tasks

The results showed that there was a high incidence of participants who stated they found many of these products difficult or impossible to use. For example, the most 'easy' product – using screwdriver was stated to be impossible for over 50% of the sample (n = 48). The graph in Appendix 9 shows the results for the use of DIY products.

4.4 The products and their difficulty in use categorised by the four motor factors

4.4.1 Order of difficulty

The table in Appendix 5 shows a list of all the products for each motor and process factor in order of difficulty of use. The different motor factors that were used to analyse the product usage produced different locations within the four motor factor lists. For example, cheese packaging produced a high ranking (poor performance) for manipulation but a low ranking (good performance) for lifting. In order to illustrate this, the worst four products for manipulation are colour coded in the lists for the three other motor factors and the process factors.

4.4.2 The products that caused most difficulty and the associated design features

The aim of the study was to identify the physical attributes of the disabled population that should be measured in order to provide data for designers for the improvement of general usability of products. As a result of this further analysis was been carried out to determine the kind of behaviour that disabled people use when interfacing with such products and hence the characteristics and capabilities of disabled people that need to be measured.

This section and Appendix 10 demonstrates the products that caused the most difficulties for the participants in the study. Five rating scores were used to evaluate the use of products by each participant whilst performing ADL (Activities of Daily Living) tasks shown below:

1 = competent

2 = adequate with some difficulty

3 = adequate with much difficulty

4 = ineffective

5 = deficit

In order to explore these products, a priority threshold was selected on the basis of the rating scores that were used during the study assessing a participant's ability to use different products. Only those that were rated 3, 4, or 5 (ie much difficulty or worse) and which were rated as such by more than 20% of the sample were considered. For example, the problems that people in the sample found with kettles gave the following results :

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	7.0	29.0	12.9	30.9
Ineffective	5.6	11.6	1.4	16.2
Deficit	1.4	4.3	1.4	2.9
Totals	**14.0**	**44.9**	**15.7**	**50.0**

The table shows that the combined rating scale scores for lifting and transporting were above the 20% threshold and gave a summed total of 44.9% and 50% respectively. Manipulation and gripping produced a summed total of 14.0% and 15.7% respectively, placing them below the 20% threshold. It can be concluded that many disabled people have considerable difficulty in using kettles and the difficulties lie primarily with lifting and transporting the product. None of the products used in the study elicited process scores above the defined threshold, excluding them from the analysis as defined.

Appendix 10 gives detailed results for the 18 products that caused most difficulty with the participants in the sample. It also identifies those design features that were associated with these difficulties.

4.5 Estimates of the number of disabled persons in the general population likely to have difficulty with certain consumer products

4.5.1 Introduction

The estimates that follow are based on the assessments of the ability of a large sample of disabled people to carry out tasks involving the use of everyday consumer products. The number who selected particular tasks on the basis that they thought they would be able to complete these tasks, determined the sub sample size in each case. The number selected by each subject was four from a list of twenty-four.

The estimates do not take into account that other subjects in the larger sample might have had, had they also chosen the tasks in question. One reason for not selecting a particular task may well have been the fact that they thought they might not be able to carry out the task. The figures given are clearly therefore underestimates.

4.5.2 Kettle

4.5.2.1 Aim : to estimate the number of disabled people likely to have difficulty using a kettle

4.5.2.2 Estimates

From the RFA results, the difficulties subjects had with kettles are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	7.0	29.0	12.9	30.9
Ineffective	5.6	11.6	1.4	16.2
Deficit	1.4	4.3	1.4	2.9
Totals	**14.0**	**44.9**	**15.7**	**50.0**

The OPCS category applies to ‘Manipulation’ and ‘Gripping’ is ‘Dexterity’. The OPCS category most applicable to ‘Lifting’ and ‘Transporting’ is ‘Reaching and stretching’. OPCS gives the following estimates for these two categories :

Type of disability	Estimated numbers in UK population
Dexterity	1,737,000
Reaching and stretching	1,230,000

Assuming the RFA sample reflects that of the OPCS sample, then estimated numbers who would have difficulties with kettles is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	15.7% x 1,737,000	273,000
Lifting and transporting	50% x 1,230,000	615,000

4.5.2.3 Estimates direct from the OPCS sample

In the OPCS report there is a specific severity rating under the category ‘Dexterity’ namely:

‘Has difficulty in picking up and pouring from a full kettle or serving food from a pan using a spoon or ladle (Severity score 6.5)’

From the OPCS report the number who have this level of severity and greater can be calculated. Based on these calculations, the estimated figure is 694,000. Such a figure compares well with the calculations from the RFA sample.

4.5.3 Tea bag packaging

4.5.3.1 Aim : to estimate the number of disabled people likely to have difficulty in opening tea bag packaging

4.5.3.2 Estimates

From the RFA results, the difficulties subjects had in opening tea bag packaging are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	20	0	16	0
Ineffective	2	0	2	2.04
Deficit	4	0	0	0
Totals	**26**	**0**	**18**	**2.04**

Using the OPCS results for ‘Dexterity’ and ‘Reaching and stretching’, the estimated numbers who would have difficulties in opening tea bag packaging is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	26% x 1,737,000	452,000
Lifting and transporting	2% x 1,230,000	25,000

4.5.4 Milk packaging

4.5.4.1 Aim : to estimate the number of disabled people likely to have difficulty in opening milk packaging

4.5.4.2 Estimates

From the RFA results, the difficulties subjects had in opening milk packaging are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	16	2	7	5
Ineffective	5	0	4	4
Deficit	1	0	0	0
Totals	**22**	**2**	**11**	**9**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening milk packaging is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	22% x 1,737,000	382,000
Lifting and transporting	11% x 1,230,000	135,000

4.5.5 Cereal packaging

4.5.5.1 Aim : to estimate the number of disabled people likely to have difficulty in opening cereal bag packaging

4.5.5.2 Estimates

From the RFA results, the difficulties subjects had in opening cereal packaging are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	41	9	25	9
Ineffective	9	0	7	4
Deficit	0	0	0	0
Totals	**50**	**9**	**32**	**13**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening cereal packaging is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	50% x 1,737,000	869,000
Lifting and transporting	32% x 1,230,000	394,000

4.5.6 Tea pots

4.5.6.1 Aim : to estimate the number of disabled people likely to have difficulty in using tea pots

4.5.6.2 Estimates

From the RFA results, the difficulties subjects had in using tea pots are shown below :

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	12	20	14	20
Ineffective	4	8	8	8
Deficit	2	4	2	2
Totals	**18**	**32**	**24**	**30**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in using tea pots is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	33% x 1,737,000	573,000
Lifting and transporting	31% x 1,230,000	381,000

4.5.7 Bread packaging

4.5.7.1 Aim : to estimate the number of disabled people likely to have difficulty in opening bread packaging

4.5.7.2 Estimates

From the RFA results, the difficulties subjects had in opening bread packaging are shown below :

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	18	3	9	6
Ineffective	3	0	3	2
Deficit	4	0	0	2
Totals	**25**	**3**	**12**	**10**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening bread packaging is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	26% x 1,737,000	452,000
Lifting and transporting	9% x 1,230,000	110,000

4.5.8 Margarine containers

4.5.8.1 Aim : to estimate the number of disabled people likely to have difficulty in opening margarine containers

4.5.8.2 Estimates

From the RFA results, the difficulties subjects had in opening margarine containers are shown below :

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	18	4	14	8
Ineffective	4	0	3	2
Deficit	2	0	1	1
Totals	**24**	**4**	**18**	**11**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening margarine containers is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	24% x 1,737,000	417,000
Lifting and transporting	12% x 1,230,000	148,000

4.5.9 Refrigerator

4.5.9.1 Aim : to estimate the number of disabled people likely to have difficulty in using a refrigerator

4.5.9.2 Estimates

From the RFA results, the difficulties subjects had in using refrigerators are shown below:

Rating	Proportion for each motor factor		
	Manipulation	Gripping	Reaching
Adequate - Much difficulty	7	5	16
Ineffective	1	1	6
Deficit	1	1	1
Totals	**9**	**7**	**23**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in using a refrigerator is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	9% x 1,737,000	156,000
Reaching to	23% x 1,230,000	283,000

4.5.10 Jam jars

4.5.10.1 Aim : to estimate the number of disabled people likely to have difficulty in opening jam jars

4.5.10.2 Estimates

From the RFA results, the difficulties subjects had in opening jam jars are shown below :

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	34	2	22	7
Ineffective	15	2	15	2
Deficit	10	0	7	0
Totals	**59**	**4**	**44**	**9**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening jam jars is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	59% x 1,737,000	1,025,000
Lifting and transporting	10% x 1,230,000	123,000

4.5.11 Plastic drink bottles

4.5.11.1 Aim : to estimate the number of disabled people likely to have difficulty opening plastic drink bottles

4.5.11.2 Estimates

From the RFA results, the difficulties subjects had in opening plastic drink bottles are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	32	3	22	10
Ineffective	6	0	5	3
Deficit	6	0	3	0
Totals	**44**	**3**	**30**	**13**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening plastic drink bottles is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	45% x 1,737,000	781,000
Lifting and transporting	13% x 1,230,000	160,000

4.5.12 Manual tin opener

4.5.12.1 Aim : to estimate the number of disabled people likely to have difficulty using a manual tin opener

4.5.12.2 Estimates

From the RFA results, the difficulties subjects using a manual tin opener are shown below :

Rating	Proportion for each motor factor		
	Manipulation	Lifting	Gripping
Adequate - Much difficulty	22	0	18
Ineffective	11	0	5
Deficit	9	7	13
Totals	**42**	**7**	**36**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in using a manual tin opener is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	43% x 1,737,000	747,000
Lifting	7% x 1,230,000	92,000

4.5.13 Cheese packaging

4.5.13.1 Aim : to estimate the number of disabled people likely to have difficulty opening cheese packaging

4.5.13.2 Estimates

From the RFA results, the difficulties subjects had in opening cheese packaging are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	40	0	22	2
Ineffective	13	2	2	0
Deficit	0	0	0	2
Totals	**53**	**2**	**24**	**4**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening cheese packaging is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	53% x 1,737,000	921,000
Lifting and transporting	4% x 1,230,000	49,000

4.5.14 Shoe polish tin

4.5.14.1 Aim : to estimate the number of disabled people likely to have difficulty in opening a shoe polish tin

4.5.14.2 Estimates

From the RFA results, the difficulties subjects had in opening a shoe polish tin are shown below :

Rating	Proportion for each motor factor		
	Manipulation	Gripping	Reaching
Adequate - Much difficulty	12.5	0	0
Ineffective	25	0	25
Deficit	12.5	0	0
Totals	50	0	25

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening a shoe polish tin are as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	50% x 1,737,000	869,000
Lifting and transporting	0% x 1,230,000	154,000

4.5.15 Instant drink packaging

4.5.15.1 Aim : to estimate the number of disabled people likely to have difficulty in opening instant drink packaging

4.5.15.2 Estimates

From the RFA results, the difficulties subjects had in opening instant drink packaging are shown below :

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	29	6	15	6
Ineffective	0	0	3	0
Deficit	9	0	0	3
Totals	**38**	**6**	**18**	**9**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in opening instant drink is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	38% x 1,737,000	660,000
Lifting and transporting	9% x 1,230,000	111,000

4.5.16 Ironing boards

4.5.16.1 Aim : to estimate the number of disabled people likely to have difficulty using an ironing board

4.5.16.2 Estimates

From the RFA results, the difficulties subjects had in using ironing boards are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	23	42	15	54
Ineffective	4	12	4	8
Deficit	0	4	4	4
Totals	**27**	**58**	**23**	**66**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers who would have difficulties in using ironing boards is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	58% x 1,737,000	1,129,000
Lifting and transporting	65% x 1,230,000	780,000

4.5.17 Microwave meal packaging

4.5.17.1 Aim : to estimate the number of disabled people likely to have difficulty in opening microwave packaging

4.5.17.2 Estimates

From the RFA results, the difficulties subjects had in opening microwave packaging are shown below :

Rating	Proportion for each motor factor	
	Manipulation	Lifting
Adequate - Much difficulty	22	21
Ineffective	9	0
Deficit	9	3
Totals	**40**	**24**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers difficulties in opening microwave packaging is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	22% x 1,737,000	382,000
Lifting and transporting	24% x 1,230,000	295,000

4.5.18 Vacuum cleaner

4.5.18.1 Aim : to estimate the number of disabled people likely to have difficulty using a vacuum cleaner

4.5.18.2 Estimates

From the RFA results, the difficulties subjects had with vacuum cleaners are shown below:

Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	17	35	22	20
Ineffective	9	0	9	0
Deficit	9	0	2	0
Totals	**35**	**35**	**33**	**20**

Using the OPCS results for 'Dexterity' and 'Reaching and stretching', the estimated numbers difficulties in using vacuum cleaners is as follows :

Type of disability	Calculation	Estimated numbers in UK population
Manipulation and gripping	35% x 1,737,000	608,000
Lifting and transporting	35% x 1,230,000	431,000

4.6 Products categorised in terms of design features and the implications for measuring the characteristics of disabled people

4.6.1 Order of difficulty

The products were examined in terms of the user design features involved in order to identify categories of products that had similar features and presented similar problems to the participants in the sample. Three main categories resulted from this examination:

- packaged products
- products incorporating controls
- products incorporating handles

The table in Appendix 5 shows a list of all the products for each motor and process factor in order of difficulty. The different motor factors that are used to analyse the product usage produce different locations within the four motor factor lists. For example, cheese packaging produces a high ranking (poor performance) for manipulation but a low ranking (good performance) for lifting. In order to illustrate this, the worst four products for manipulation are colour coded in the lists for the three other motor factors and the process factors.

The following sections show the categorised products in terms of four motor factors. The tables included show the product order generated by the sorted product graphs shown in

Appendix 6. Some products, which are related to tasks that were performed least often, had a cell size that was not sufficient to produce reliable data. These products were excluded from the order of categorised products. The products that were excluded are listed below the tables. Also, listed below each table are comments that compare products with similar attributes and explain differences in their position in the order of difficulty table.

4.6.2 Category 1 - Packaging products

4.6.2.1 Packaging products - manipulation

The order of difficulty of packaging products (1 being the easiest) is shown in the table below:

Packaging products - manipulation

1	Cleaning solution	11	Tea bag
2	Washing up liquid	12	Instant soup packaging
3	Soup tin	13	Meat tin
4	Sugar	14	Plastic bottle
5	Washing powder/liquid	15	Toothpaste
6	Tin of tuna	16	Cereal packaging
7	Butter	17	Cheese packaging
8	Milk	18	Jam jar
9	Microwave meal packaging	19	Shoe polish tin
10	Bread packaging		

Products excluded from the list because of small sample numbers include:

- No products excluded

Product comparison

- Both jam jars and plastic beverage bottles require the application of contra rotating forces to open them. The higher ranking position of plastic bottles when compared to that of jam jars has been attributed to the smaller diameter of the top that must be twisted and the superior gripping characteristics of the textured bottle top surface. Also the force required to initially open the jam jar was higher than that of the plastic bottle, as reported by the comments made by the participants in the study.
- Both the shrink-wrap packaging used on cheese, and the air-tight inner packaging in cereal boxes, were found to require the use of scissors or knives to open by a large proportion of the sample. None of the participants were able to open the cheese packaging without a tool, and 40 of 44 participants who used the cereal packaging used either a knife or scissors to open them. Since the cheese packaging always needed to be opened in conjunction with a tool, it is placed towards the more difficult end when compared to cereal packaging.
- Products that require the use of pull-tabs such as teabag packaging, bread packaging and butter packaging were found to be in the mid-range of difficulty of use order. The size, ease of locating, and grip-ability of these tabs were cited as the cause of difficulty in the comments recorded during the experiment.

Best and worst products

- The product found to be easiest to use in terms of manipulation was cleaning product packaging that incorporates a flip top lid.
- Although not often used, the most difficult product to manipulate was the shoe polish tin. Gripping the small opening handle of the shoe polish tin caused severe problems for participants. Bearing in mind the participants selected tasks that they thought they were able to do, 43% of participants were unable to open the shoe polish tin.

Conclusions for packaging products - manipulation

The product order list has illustrated the type of packaging and packaging opening mechanisms that cause most and least difficulty for disabled people (especially when two hands need to be used). In general terms, the packaging products that require fine manipulation and the application of high levels of grip force cause most difficulty. In order to design better packaging for use by the disabled and non-disabled population, the force application and manipulation ability of these two populations should be measured in any proposed second phase. The manipulation skills that have been shown to cause difficulty should be quantified and measured using devices that simulate tasks as realistically as possible. These are:

- the maximum contra-rotating torque that can be exerted using two hands
- the maximum force that can be exerted when pulling tabs of different sizes whilst using the other hand to stabilise
- the maximum tear force that can be applied

4.6.2.2 Packaging products - gripping

The order of difficulty of packaging products used (1 being the most easy) is shown in the table below:

Packaging products - gripping

1	Cleaning solution	11	Tea bag
2	Microwave meal packaging	12	Tin of tuna
3	Instant soup packaging	13	Plastic bottle
4	Soup tin	14	Cheese packaging
5	Washing powder/liquid	15	Meat tin
6	Sugar	16	Toothpaste
7	Milk	17	Shoe polish
8	Washing up liquid	18	Cereal packaging
9	Bread packaging	19	Jam jar
10	Butter		

Products excluded from the list because of small sample numbers include:

- No excluded products

Products comparison

- As with the manipulation factor, the jam jars produced the highest difficulty rating for the participants in the study for the gripping factor. The plastic bottle again was placed higher than the jam jar, as referred to in the Section above eg diameter and textured surfaces of both the jam jar lid and plastic bottle lid.
- As with the manipulation factor, the combination of large outer packaging and smooth strongly sealed inner packaging made cereal packaging the next most difficult to use in terms of grip.
- Gripping of the small opening device used on traditional shoe polish tins placed this product packaging as the third most difficult to grip.
- The easiest products to use in the list of difficulty were found to be cleaning solution bottles. In the list of order of difficulty for manipulation the cleaning solution bottles and washing up liquid bottles were found to be the easiest to use. In this, the washing up liquid bottle is found to be in the mid-range of difficulty of use. The cleaning solution bottle used in the study generally had a tapered neck from the top to the middle of the bottle, providing the 'waist' of the bottle with a smaller diameter. This made the bottle easier to grip than the washing up liquid bottle which had the same diameter and cross sectional shape through it's whole height.

Conclusions for packaging products – gripping

The product order list has illustrated the type of packaging products that cause most and least difficulty for disabled people. In general terms, the products that require high force levels, necessitating the use of assistive devices caused the most difficulty for participants. The packaging designs that have been examined in the study have suggested a number of manipulative skills that should be investigated in any proposed second phase. These are:

- the optimum diameters for twist off devices such as lids for different force levels
- the maximum force that can be exerted when pulling apart packaging
- the optimum size of pull tabs and their surface characteristics

These tests should be performed with representative samples of both disabled and non-disabled people.

4.6.2.3 Packaging products – lifting

The order of difficulty of packaging products used (1 being the most easy) is shown in the table below:

Packaging products - lifting

1	Shoe polish	11	Milk
2	Tin of tuna	12	Jam jar
3	Tea bag	13	Toothpaste
4	Instant soup packaging	14	Cereal packaging
5	Meat tin	15	Soup tin
6	Cleaning solution	16	Washing powder/liquid
7	Butter	17	Sugar
8	Bread packaging	18	Microwave meal packaging
9	Cheese packaging	19	Washing up liquid
10	Plastic bottle		

Products excluded from the list because of small sample numbers include:

- No excluded products

Product comparison

- Washing up liquid – cleaning solution. Washing up liquid packaging has been shown to be worse in terms of lifting (it is acknowledged that the container was sometimes wet during this task making lifting and gripping more difficult). However, the container for kitchen cleaning solution produced a difficulty level far lower than that of the washing

up liquid container, although they were of equivalent size. Examination of the comments recorded attributed the difference to the shape of the containers. The cleaning solution packaging used in the study had a tapered 'waist' whereas the washing up liquid bottle had the same cross section throughout its height. The tapered waist allowed the participants to grip the bottle more effectively and therefore lift it more easily. In particular, the following measures need to be made:

- the maximum one handed lifting force at different distances to the front and side of the body
- the maximum lifting force for different frictional surfaces

Conclusions for packaging products – lifting

The list above shows that lifting packaging products was not necessarily related to the weight of that product. The two products shown to be the worst for lifting are relatively light when compared to packaging items such as washing powder boxes or sugar bags which are lower in the list of difficulty. This emphasised the need to explore the size, shape and weight of packaging that can be most easily lifted by the disabled population. In particular the following measures need to be made:

- the maximum force that can be lifted with one hand at different distances in front of the body
- the maximum force that can be lifted from different levels

4.6.2.4 Packaging products – transporting

The order of difficulty (1 being the easiest) of packaging products used is shown in the table below:

Packaging products - transporting

1	Cleaning solution	9	Tin of tuna
2	Tea bag	10	Jam jar
3	Instant soup packaging	11	Butter
4	Toothpaste	12	Washing powder/liquid
5	Milk	13	Microwave meal packaging
6	Bread packaging	14	Sugar
7	Cereal packaging	15	Washing up liquid
8	Plastic bottle		

Products excluded from the list because of small sample numbers include;

- No excluded products

Conclusions for packaging products – transporting

As transporting was a combination of lifting and gripping, the recommendations made on the measurements made for these two motor factors apply to transporting. Indeed, the ordered list for transporting was very similar to that for lifting. In particular the following should be measured:

- the amount of weight that can be lifted from different levels

4.6.3 Category 2 - Products incorporating handles

In terms of the definitions of the motor factors that can be seen in Appendix 7 manipulation, lifting and gripping are the motor factors applicable to the analysis of products incorporating controls.

4.6.3.1 Products incorporating handles - manipulation

The order of difficulty (1 being the easiest) of products used incorporating handles is shown in the table below:

Products incorporating handles – manipulation

1	Telephone	8	Kettle
2	Dust pan brush	9	Knife
3	Mugs/cups	10	Tea pot
4	Sauce pan	11	Dust pan
5	Grill tray	12	Dish brush
6	Iron	13	Vacuum cleaner
7	Peeler	14	Tin opener

Products excluded from the list because of small sample numbers include;

- Mop bucket, mop, broom

Product comparison

- The weight and centre of gravity of teapots and kettles are similar suggesting that it was most likely the handle design of kettles that placed them below (easier to use) teapots on the scale difficulty. This is demonstrated by the fact that kettle handles have a relatively large diameter, whereas teapots traditionally have thin small handles. These smaller thinner handles exert force on the hand over a smaller surface area than the thicker kettle handles, causing discomfort, fatigue and instability more rapidly.
- Kettle and iron handle designs are similar and so the placement of the kettle towards the 'difficult' end of the scale is attributed to the extra weight involved.
- The better performance of the peeler over the knife was attributed to the relatively large and circular diameter of the peeler handle when compared to the knife handle, making the product easier to manipulate and grip.

Best and worst products

- The telephone handle and the dust pan brush are both lightweight devices with large easy to grip handles that require relatively low force levels for their operation.
- Locating the tin opener on the rim of the tin, squeezing the tin opener handles in order to pierce the lid, and rotating the 'T' shaped handle, make tin openers the most difficult product to use in this category.
- Of the 50 instances of vacuum cleaner use, 47 involved the use of upright vacuum cleaners. Their high position on the scale of difficulty is therefore attributed to the design of the handle and the weight and size of the vacuum cleaners. In addition, vacuum cleaners often require the application of combined forces. For example, upright vacuum cleaners often require a pedal close to the floor to be depressed whilst the handle is being pulled towards the user.

Conclusions for products incorporating handles – manipulation

The product order list has illustrated the type of products incorporating handles that cause most and least difficulty for disabled people. In general terms, the products incorporating handles that require the application of forces with both hands such as tin openers and vacuum cleaners, caused the most difficulty. This suggests that the ability to apply different types of force in combination should be explored in any proposed second phase.

4.6.3.2 Products incorporating handles - gripping

The order of difficulty (1 being the easiest) of products incorporating handles is shown in the table below:

Products incorporating handles - gripping

1	Peeler	8	Knife
2	Dust pan brush	9	Kettle
3	Mugs/cups	10	Dust pan
4	Sauce pan	11	Tea pot
5	Telephone	12	Dish brush
6	Grill tray	13	Tin opener
7	Iron	14	Vacuum cleaner

Products excluded from the list because of small sample numbers include:

- No products excluded

Product comparison

- Since the motor factors of manipulation and gripping are closely linked, the related product orders for tea pots, kettles and irons that have been shown in the table for manipulation above (in the section dealing with the manipulation of products incorporating handles) are evident with the gripping of products incorporating handles. There are however some differences in the ordering of other products in the overall list. The vacuum cleaner has replaced the tin opener as the worst product in the gripping list. A higher percentage had difficulty in gripping the vacuum handle as opposed to manipulating the various vacuum cleaner controls and devices when the lists for gripping and manipulation are compared, possibly due to the force that must be applied to push the vacuum cleaner along.
- Basic gripping of the peeler was found to be easier than manipulating the peeler during use, illustrated by the lower (better) position of the peeler in the gripping order list when compared to the manipulation order list.
- The grill tray has been shown to be harder to grip and lift than the saucepan. This is attributed to the centre of gravity of the load that is to be carried by the handle. With the saucepan the centre of gravity is central, and below the plane of the handle. The grill tray has a higher centre of gravity, on the same plane as the handle. This requires more gripping strength and wrist strength to provide stability.

Best and worst products

- The best three products incorporating handles were found to be peelers, the dustpan and brush and mugs/cups. These four products demonstrated relatively low force application levels when compared to the rest of products in the list.

Conclusions for product incorporating handles – gripping

The product order list has illustrated the type of products incorporating handles that cause most and least difficulty for disabled people. In general terms the products that require high force levels were found to be the most difficult to use. A range of handle designs that encompass the range of force types such as push, pull and rotate should be used in the next phase of the study to determine the limits of force application ability for both the disabled and non-disabled population.

4.6.3.3 Products incorporating handles – lifting

The order of difficulty (1 being the easiest) of products incorporating handles is shown in the table below:

Products incorporating handles - lifting

1	Kettle	10	Vacuum cleaner
2	Grill tray	11	Iron
3	Tea pot	12	Milk
4	Sauce pan	13	Mugs/cups
5	Telephone	14	Dish brush
6	Peeler	15	Dust pan
7	Tooth brush	16	Dust pan brush
8	Tin opener	17	Knife
9	Various laundry		

Products excluded from the list because of small sample numbers include:

- Mop bucket, mop, broom

Conclusions for products incorporating handles

Unlike the packaging products, products incorporating handles do show the difficulty in use in terms of the weight of the products. The top five worst products that are shown in the list are the heaviest of the products tested. This suggests that handles that necessitate a range of hand arm postures, used in combination with different surface characteristics and weights should be used to explore optimal configurations for the disabled and non-disabled populations.

4.6.3.4 Products incorporating handles - transporting

The order of difficulty (1 being the easiest) of products incorporating handles is shown in the table below:

Products incorporating handles - transporting

1	Dish brush	9	Mop bucket
2	Dust pan	10	Dust pan brush
3	Broom	11	Mugs/cups
4	Knife	12	Vacuum cleaner
5	Milk	13	Tea pot
6	Iron	14	Grill tray
7	Peeler	15	Kettle
8	Telephone		

Products from the list because of small sample include:

- Tin opener and various laundry items

Conclusions for products incorporating handles - transporting

As transporting is a combination of lifting and gripping, the recommendations made on the measurements made for these two motor factors apply to transporting. Indeed, the ordered list for transporting is very similar to that for lifting. In particular the following measures need to be made:

- the ability to carry objects of various weights and handle configuration over a range of distances

4.6.4 Category 3 - Products incorporating controls

In terms of the definitions of the motor factors that can be seen in Appendix 7 manipulation is only the motor factor that is applicable to the analysis of products incorporating controls.

4.6.4.1 Products incorporating controls - manipulation

The order of difficulty (1 being the easiest) of products used incorporating controls is shown in the table below:

Products incorporating controls - manipulation

1	Video remote	9	Fridge
2	Grill controls	10	Television remote
3	Telephone	11	Taps
4	Plug socket	12	Washing machine
5	Hob controls	13	Kettle
6	Video recorder	14	Toaster
7	Microwave	15	Vacuum cleaner
8	Iron	16	Tin opener

Products excluded from the list because of small sample numbers include:

- No excluded products

Products comparison

- There should be no appreciable difference in manipulating and gripping of the hob and grill controls as they are normally located on the same panel and generally have the same shape and torque characteristics. The graphs in Appendix 6 show that there is little difference in the perceived difficulty of use between these two controls. The difference in positioning in the list of difficulty is attributed to a small percentage of the participants who demonstrated an inability to use the hob controls, whereas no participants were unable to the grill controls.
- There is a large difference in the difficulty order between the two remote controls. Reference to the graph in Appendix 6 shows that the difference is attributed to 8.5% of the participants who had much difficulty in manipulating the television remote whereas no participants had much difficulty in manipulating the video remote. The task that the video remote was used for was to simply start and stop a videotape. The task that the TV remote was used for was to change between several channels. Video remote controls tend to have the main functions in an array of large buttons, including play, stop, fast-forward and rewind. This is compared to the TV remote where channel selection is still made using any of ten small buttons. It is suggested that this accounts

for the difference in the order between the two products.

Best and worst products

- The video remote and grill controls are both devices that require small forces to be applied for their operation, and are therefore found easy to use. In comparison to the tin opener and vacuum cleaner that require relatively large forces.

Conclusions for products incorporating controls – manipulation

The product order list has illustrated the type of products incorporating controls that cause most and least difficulty for disabled people. In general terms the products incorporating controls that require the application of combined forces such as tin openers and vacuum cleaners cause the most difficulty. This suggests that the application ability of different force types in combination should be explored in any proposed second phase. Also, the difficulty shown in the use of television remote controls suggests that the optimal size and spacing of push buttons should be explored in the next phase of the study.

4.7 The relationship between age and difficulty with different products/tasks

After the study had commenced, the hypotheses put forward was that there would be a difference in tasks selected by those 59 years and under and those over 60 years of age. Unfortunately the sampling was not made on the basis of age, in order to reflect the distribution in the general population. The numbers in the sample aged above and below 60 years of age was therefore arbitrary. Of the 218 subjects who participated in the research, 48 were over the age of 60. Appendix 8 shows a comparison between the scores for a range of products between the under and over 60s. In the vast majority of cases the over 60's actually performed slightly better than the under 60s.

A number of reasons could be put forward for this difference:

- since age distribution was not considered during sampling, the levels of severity of disability in the under and over 60 years group with regard to functions such as manipulation and dexterity may be arbitrary
- all other things equal, there is likely to be a greater incidence of chronic disability arising from trauma or disease in the younger group than with the older group where 'infirmities' of age are likely to predominate
- only in the very old age group is the incidence of severe disability likely to be high. Very few such persons were included in this study.

The deliberate skewing of the sample towards the more severely disabled members of the population to more fully explores the problems that products cause exacerbated this situation. The difference between the performances of the two age groups is not thought to be of a significant level.

5.0 CONCLUSIONS

The literature study demonstrated there was little evidence or data on the problems that disabled people have with consumer products. Methods for assessing the difficulties that disabled people have are frequently carried out by occupational therapists in order to assess the level of support required. These are called Activities of Daily Living assessments (ADL). Such assessments however take little heed of design deficiencies of products or environmental features. Unfortunately there is no generally accepted standardised method of ADL assessment neither is there any normative data.

The literature survey did however identify a method of assessment developed in the USA namely the Assessment of Motor and Process Skills (AMPS) which was well structured, was cross culturally sound and for which normative data existed. In principle, the AMPS approach was used for this study with certain adaptations to suit its specific aims.

The representivity of the sample as tested against the UK OPCS (1989) survey of disabled adults in Britain carried out in 1989 showed that all of the different functional groups were represented at all levels of severity. However, because the sample drew on people who had difficulties with Daily Living, inevitably the sample in this study represented somewhat more severe functional groups than in the OPCS study. The age range of the sample compared with general statistics of the UK general population demonstrated that all ages in the range were represented with a tendency to over representation of those over 60 years of age. This arose because the majority of disabled people are over 60 years.

The interview and assessment study highlighted a number of products that caused difficulty for disabled people. These included packaging, household utensils, machine controls and large and heavy items such as vacuum cleaners. A simple questionnaire survey showed that most disabled people cannot use most DIY and garden implements.

The detailed analysis of the problems participants had with those tasks and products selected for assessment gave a clear indication of the nature and type of functional demands such products make on disabled people. As a result of this analysis the characteristics and capabilities of disabled people that need to be measured was identified.

As a follow up to this study DTI have contracted RFA to look at the feasibility of collecting hard data of disabled peoples characteristics and capabilities.

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APPENDIX 1

OPCS severity scales

Locomotion		Severity score
L1	Cannot walk at all	11.5
L2	Can only walk a few steps without stopping or severe discomfort/ Cannot walk up and down one step	9.5
L3	Has fallen 12 or more times in the last year	7.5
L4	Always needs to hold on to something to keep balance	7.0
L5	Cannot walk up and down a flight of 12 stairs	6.5
L6	Cannot walk 50 yards without stopping or severe discomfort	5.5
L7	Cannot bend down far enough to touch knees and straighten up again	4.5
L8	Cannot bend down and pick something up from the floor and straighten up again	4.0
L9	Cannot walk 200 yards without stopping or severe discomfort/Can only walk up and down a flight of 12 stairs if holds on and takes a rest/Often needs to hold onto something to keep balance/Has fallen 3 or more times in the last year	3.0
L10	Can only walk-up and down a flight of 12 stairs if holds on (doesn't need a rest)	2.5
L11	Cannot bend down to sweep something from the floor and straighten up again	2.0
L12	Can only walk up and down a flight of 12 stairs if goes sideways or one step at a time	1.5
L13	Cannot walk 400 yards without stopping or severe discomfort	0.5

Reaching and stretching		Severity score
RS1	Cannot hold out either arm in front to shake hands	9.5
RS2	Cannot put either arm up to head to put a hat on	9.0
RS3	Cannot put either hand behind back to put jacket on or tuck shirt in	8.0
RS4	Cannot raise either arm above head to reach for something	7.0
RS5	Has difficulty holding out either arm in front to shake hands with someone	6.5
RS6	Has difficulty putting either arm up to head to put a hat on	5.5
RS7	Has difficulty putting either hand behind back to put jacket on or tuck shirt in	4.5
RS8	Has difficulty raising either arm above head to reach for something	3.5
RS9	Cannot hold one arm in front or up to head (but can with other arm)	2.5
RS10	Cannot put one arm behind back to put on jacket or tuck shirt in (but can with other arm)/ Has difficulty putting one arm out in front or up to head (but no difficulty with other arm)	1.0

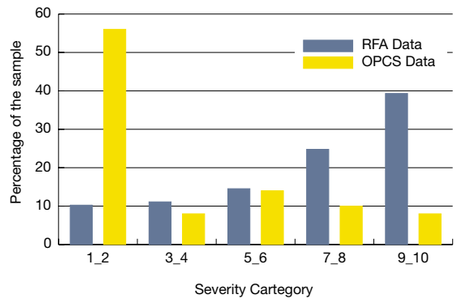
Dexterity		Severity score
D1	Cannot pick up and hold a mug of coffee with either hand	10.5
D2	Cannot turn or control knobs on a cooker with either hand	9.5
D3	Cannot pick up or carry a pint of milk or squeeze the water from a sponge	8.0
D4	Cannot pick up a small object such as safety pin with either hand	7.0
D5	Has difficulty picking up and pouring from a full kettle or serving food from a pan using a spoon or ladle	6.5
D6	Has difficulty unscrewing the lid of a coffee jar or using a pen or pencil	5.5
D7	Cannot pick up and carry a 5lb bag of potatoes with either hand	4.0
D8	Has difficulty wringing out light washing or using a pair of scissors	3.0
D9	Can pick up and hold a mug of tea or coffee with one hand but not the other	2.0
D10	Can turn a tap or control knob with one hand but not with the other/ Can squeeze the water from a sponge with one hand but not the other	1.5
D11	Can pick up a small object such as a safety pin with one hand but not with the other/ Has difficulty tying a bow in laces or strings	0.5

Vision		Severity score
S1	Cannot tell by the light where the windows are	12.0
S2	Cannot see the shapes of furniture in the room	11.0
S3	Cannot see well enough to recognise a friend if close to his face	10.0
S4	Cannot see well enough to recognise a friend who is an arm's length away	8.0
S5	Cannot see well enough to read a newspaper headline	5.5
S6	Cannot see well enough to read a large print book	5.0
S7	Cannot see well enough to recognise a friend across a room	4.5
S8	Cannot see well enough to recognise a friend across a road	1.5
S9	Has difficulty seeing to read ordinary newspaper print	0.5

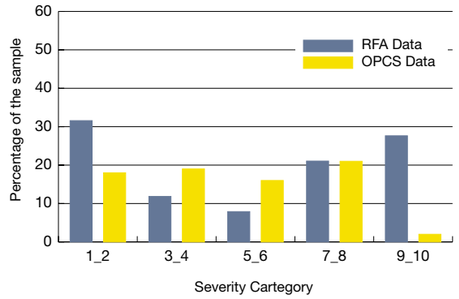
Hearing		Severity score
H1	Cannot hear sounds at all	11.0
H2	Cannot follow a TV programme with the volume turned up	8.5
H3	Has difficulty hearing someone talking in a loud voice in a quiet room	6.0
H4	Cannot hear a doorbell, alarm clock or telephone bell	5.5
H5	Cannot use the telephone	4.0
H6	Cannot follow a TV programme at a volume others find acceptable	2.0
H7	Difficulty hearing someone talking in a normal voice in a quiet room	1.5
H8	Difficulty following a conversation against background noise	0.5

A comparison between the severity of disability between the OPCS and RFA samples

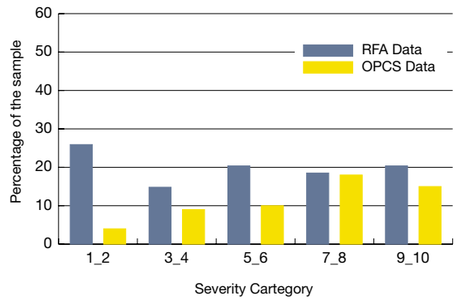
A comparison between the severity of disability in terms of locomotion between the OPCS sample and RFA samples.



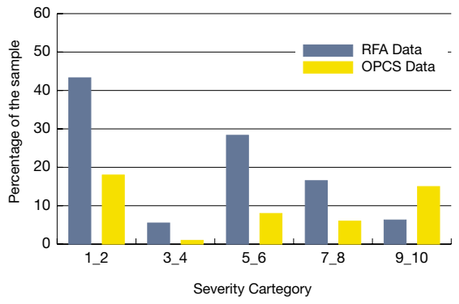
A comparison between the severity of disability in terms of dexterity between the OPCS sample and RFA samples.



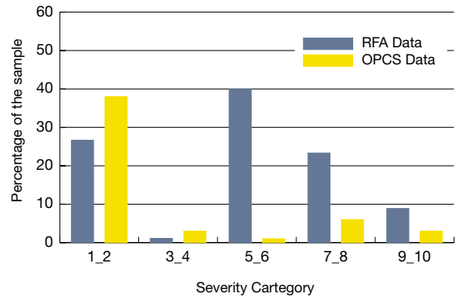
A comparison between the severity of disability in terms of reaching and treaching between the OPCS sample and RFA samples.



A comparison between the severity of disability in terms of visual impairment between the OPCS sample and RFA samples.



A comparison between the severity of disability in terms of hearing between the OPCS sample and RFA samples.



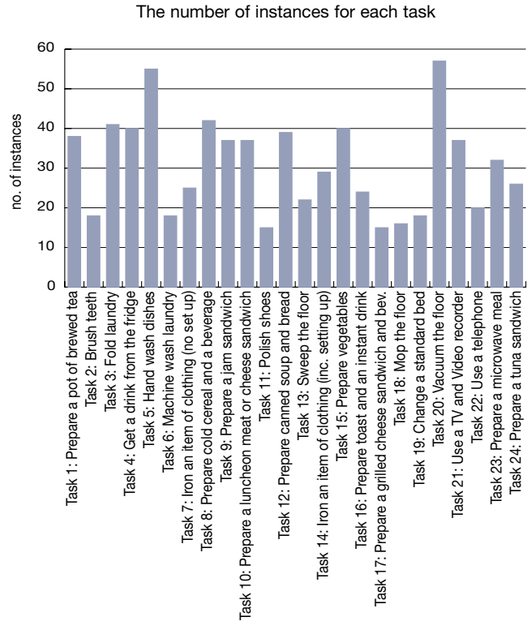
APPENDIX 3

The order of difficulty of tasks as defined by the AMPS system and the RFA research

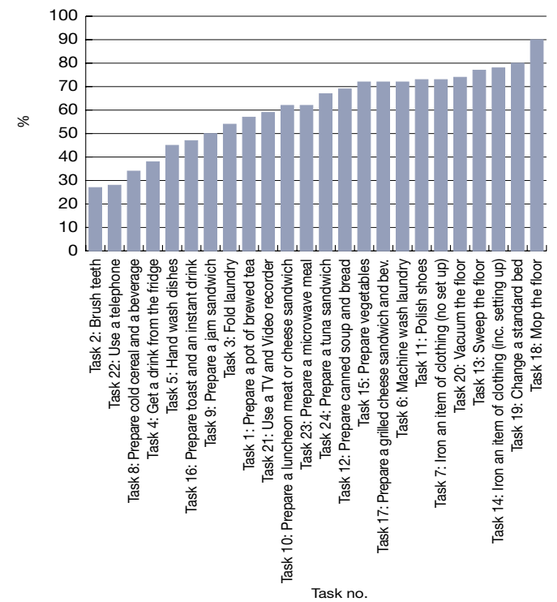
AMPS order of tasks	RFA order of tasks
Task 2: Brush teeth	Task 2: Brush teeth
Task 8: Prepare cold cereal and a beverage	Task 3: Fold laundry
Task 4: Get a drink from the fridge	Task 4: Get a drink from the fridge
Task 5: Hand wash dishes	Task 16: Prepare toast and an instant drink
Task 16: Prepare toast and an instant drink	Task 5: Hand wash dishes
Task 9: Prepare a jam sandwich	Task 6: Machine wash laundry
Task 3: Fold laundry	Task 7: Iron an item of clothing (no set up)
Task 1: Prepare a pot of brewed tea	Task 8: Prepare cold cereal and a beverage
Task 10: Prepare a luncheon meat or cheese sandwich	Task 9: Prepare a jam sandwich
Task 24: Prepare a tuna sandwich	Task 10: Prepare a luncheon meat or cheese sandwich
Task 12: Prepare canned soup and bread	Task 11: Polish shoes
Task 15: Prepare vegetables	Task 12: Prepare canned soup and bread
Task 17: Prepare a grilled cheese sandwich and bev.	Task 1: Prepare a pot of brewed tea
Task 6: Machine wash laundry	Task 13: Sweep the floor
Task 11: Polish shoes	Task 14: Iron an item of clothing (inc. setting up)
Task 7: Iron an item of clothing (no set up)	Task 24: Prepare a tuna sandwich
Task 20: Vacuum the floor	Task 15: Prepare vegetables
Task 13: Sweep the floor	Task 17: Prepare a grilled cheese sandwich and bev.
Task 14: Iron an item of clothing (inc. setting up)	Task 18: Mop the floor
Task 19: Change a standard bed	Task 19: Change a standard bed
Task 18: Mop the floor	Task 20: Vacuum the floor

APPENDIX 4

The number of instances of each task and the proportion of the sample who reported that they could perform the tasks that they did not perform during the experiment



The 24 tasks showing which tasks were considered possible by participants sorted with the least possible on the right.



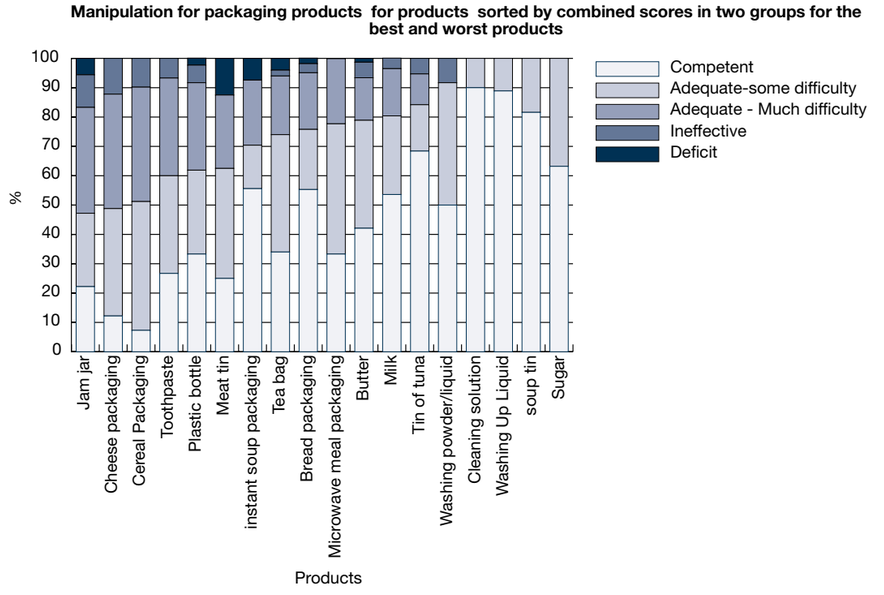
APPENDIX 5

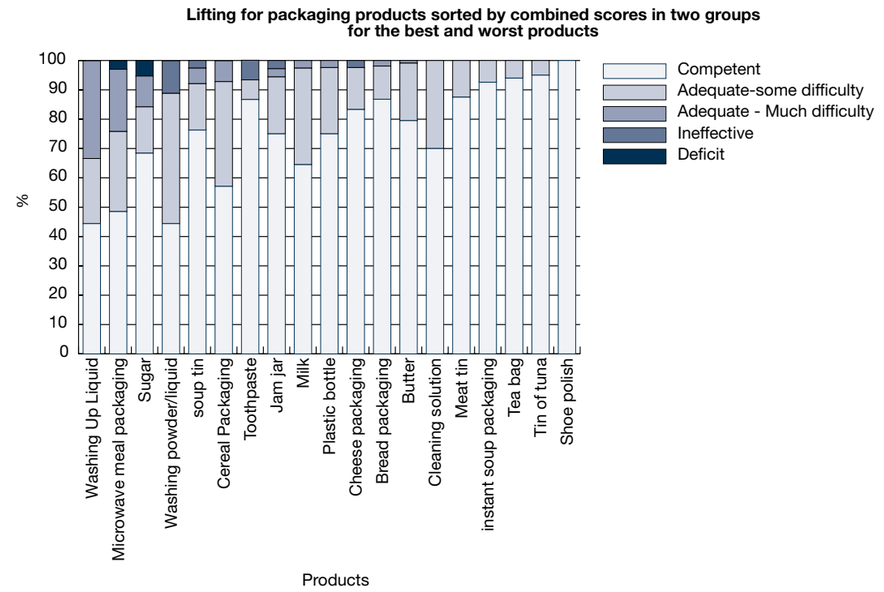
Product order of difficulty in terms motor and process skills (most difficult to use at the top)

Manipulate	Grip	Lift	Transport	Notice	Sequence	Using	Terminating
Cereal Pack.	Cereal Pack.	Grill tray	Ironing board	Iron	Video recorder	Toothpaste	Video recorder
Cheese pack.	Vacuum cleaner	lightweight furniture	lightweight furniture	Washing machine	Laundry (wet)	Meat tin	Broom
Jam jar	Mop bucket	Ironing board	Grill tray	Shoe polish	Telephone	Shoe polish	Dust pan
Meat tin	Wash Basket	Kettle	Kettle	Toaster	Video cassette	Cereal Pack.	Microwave meal pack.
Mop bucket	Jam jar	Tea pot	Tea pot	Video recorder	Shoe polish	Mop bucket	Video cassette
Plug socket	Duvet	Video cassette	Sheets	Vacuum cleaner	Dust pan brush	Sheets	Peeler
Vacuum cleaner	Telephone	Washing Up Bowl	Various Laundry	Microwave	Microwave	Various Laundry	Telephone
Toothpaste	Plastic bottle	Washing powder/liquid	Video cassette	Tea bag	Tin of tuna	Peeler	Video remote
Wash Basket	Kettle	Washing Up liquid	Laundry (wet)	Video remote	Video remote	Washing machine	Toaster
Shoe polish	Shoe polish	Microwave meal pack.	Jam jar	polish cloth	polish cloth	Mop	Toothpaste
Plastic bottle	Tea pot	Mop bucket	Cereal Pack.	Broom	Vacuum cleaner	Laundry (wet)	Iron
Microwave meal pack.	Tea bag	Duvet	Duvet	Dust pan	Toaster	Tin opener	Sheets
Tea bag	Tin opener	Sauce pan	Washing Up Bowl	Grill controls	Iron	Iron	Microwave
Ironing board	Toothpaste	Cereal Pack.	Glass	Plug socket	Tele remote	Telephone	Sugar
Tin opener	Video cassette	Telephone	Mugs/cups	Video cassette	polish brush	Duvet	Tin of tuna
Toaster	Cheese pack	Various Laundry	Washing powder/liquid	Wash Basket	Sugar	Video cassette	Cheese pack.
polish cloth	Milk	Mop	Mop bucket	Microwave meal pack.	Duvet	Washing powder/liquid	Tin opener
Milk	Meat tin	Various Dishes	Cleaning solution	instant soup pack.	Bread bin	Video recorder	Ironing board
Various Laundry	Ironing board	Wash Basket	Vacuum cleaner	Cereal Pack.	Coat hanger	Toaster	instant soup pack.
Washing powder/liquid	Grill tray	Milk	Bowl	Cheese pack.	Shoes	Wash Basket	Bowl
Telephone	Various Laundry	Vacuum cleaner	Plate	Tele remote	soup tin	Microwave	Glass
Butter	Various Dishes	Sugar	Butter	Dust pan brush	Various Laundry	Plastic bottle	Chopping board
Washing machine	Toaster	Tooth brush	Milk	Various Laundry	Tea bag	Cheese pack.	Tele remote
Bread pack.	instant soup pack.	Cleaning solution	Plastic bottle	Grill tray	Washing machine	Milk	Butter
instant soup pack.	Laundry (wet)	Video remote	Microwave meal pack.	Ironing board	Tin opener	Milk	Cereal Pack.
Peeler	Sugar	Laundry (wet)	Sugar	Sheets	Mop	polish cloth	Vacuum cleaner
Laundry (wet)	Washing Up Bowl	Sheets	Mop	Butter	Cheese pack.	Broom	Various Laundry
Various Dishes	Butter	Bowl	Various Dishes	soup tin	Various Dishes	Pillow case	Bread pack.
Knife	Washing powder/liquid	Dish brush	Bread pack.	Sugar	Glass	Dust pan	Bread bin
Duvet	polish cloth	Jam jar	Tele remote	Kettle	Chopping board	Ironing board	Taps
Tooth brush	Bread pack.	Pillows	Washing Up liquid	Coat hanger	Bread pack.	Vacuum cleaner	Milk
Washing Up Bowl	Knife	Plastic bottle	Tea bag	Various Dishes	Butter	Pillows	Mugs/cups
lightweight furniture	Sauce pan	soup tin	Wash Basket	Tooth brush	Fridge	Tea bag	Plastic bottle
Tea pot	Washing Up liquid	Peeler	Chopping board	Tin opener	Ironing board	Tea bag	Plate
Sugar	Washing machine	Glass	Iron	Glass	instant soup pack.	Tooth brush	Knife
Kettle	Mop	Mugs/cups	Video remote	Tea pot	Kettle	Sugar	Kettle
Shoes	Sheets	Iron	Dust pan brush	Toothpaste	Plastic bottle	Various Dishes	Tea bag
Tin of tuna	Tele remote	Butter	Telephone	Duvet	Bowl	Cleaning solution	Tea pot
Tele remote	Mugs/cups	Tin opener	Peeler	Milk	Cereal Pack.	Dust pan brush	Tooth brush
Grill tray	Bowl	Chopping board	Dish brush	Mugs/cups	Washing Up Bowl	Glass	Fridge
Iron	Tooth brush	Cheese pack.	instant soup pack.	Bread pack.	Tea pot	Microwave meal pack.	Washing Up liquid
Mop	Tin of tuna	Plate	storage containers	Plastic bottle	Grill tray	Bread pack.	Washing Up Bowl
Video cassette	Taps	Plug(Elec)	Meat tin	Sauce pan	Plate	Grill tray	Various Dishes
Sauce pan	Glass	Dust pan brush	Tooth brush	Fridge	Hob controls	Jam jar	Dish Sponge
Dish brush	Peeler	Coat hanger	Tin of tuna	Hob controls	Sheets	Shoes	Dish brush
Microwave	soup tin	Pillow case	Pillows	Knife	Milk	Washing Up Bowl	Washing machine
Glass	Iron	Toothpaste	Toothpaste	Tin of tuna	Knife	Butter	Washing powder/liquid
Grill controls	Dish brush	Bread pack.	Knife	Peeler	storage containers	Knife	Coat hanger
Taps	Plate	Meat tin	Coat hanger	Telephone	Plug(Elec)	Chopping board	Jam jar
Broom	Shoes	instant soup pack.	Dish Sponge	Chopping board	Sauce pan	Tele remote	Meat tin
Dust pan	Bread bin	Knife	Broom	Jam jar	Dish Sponge	Hob controls	Shoe polish
Hob controls	Broom	Tea bag	Plug(Elec)	Bowl	Jam jar	soup tin	Shoes
Bowl	lightweight furniture	Tele remote	Dust pan	Plate	Taps	instant soup pack	polish brush
Bread bin	Cleaning solution	Tin of tuna	Cheese pack.	Bread bin	Mugs/cups	Kettle	polish cloth
soup tin	Microwave	storage containers		Taps	Tooth brush	storage containers	soup tin
Plate	Dust pan	Broom		Washing Up liquid	Toothpaste	Taps	Hob controls
Mugs/cups	Fridge	Dish Sponge		Washing Up Bowl	Washing Up liquid	lightweight furniture	Sauce pan
polish brush	Microwave meal pack.	Dust pan		Dish Sponge	Dish brush	Coat hanger	lightweight furniture
Sheets	Chopping board	polish brush		Dish brush	Washing powder/liquid	Bowl	Plug(Elec)
Fridge	Hob controls	polish cloth		Washing powder/liquid	Meat tin	Sauce pan	Plug socket
storage containers	storage containers	Shoe polish		Meat tin	Broom	Plug socket	storage containers
Video recorder	Dish Sponge	Shoes		Shoes	lightweight furniture	Fridge	Grill tray
Video remote	Grill controls			polish brush	Plug socket	Tin of tuna	Grill controls
Washing Up liquid	Video recorder			lightweight furniture	Grill controls	Mugs/cups	Mop
Cleaning solution	Pillow case			Plug(Elec)	Mop bucket	Bread bin	Mop bucket
Chopping board	Pillows			storage containers	Cleaning solution	Tea pot	Cleaning solution
Dish Sponge	Video remote			Mop	Pillows	Video remote	Pillows
Pillow case	Coat hanger			Mop bucket	Pillow case	Plug(Elec)	Pillow case
Coat hanger	polish brush			Cleaning solution	Wash Basket	Dish Sponge	Duvet
Plug(Elec)	Plug(Elec)			Pillows	Microwave meal pack.	Plate	Wash Basket
Pillows	Plug socket			Pillow case	Peeler	Washing Up liquid	Dust pan brush
Dust pan brush	Dust pan brush			Laundry (wet)	Dust pan	Dish brush	Laundry (wet)

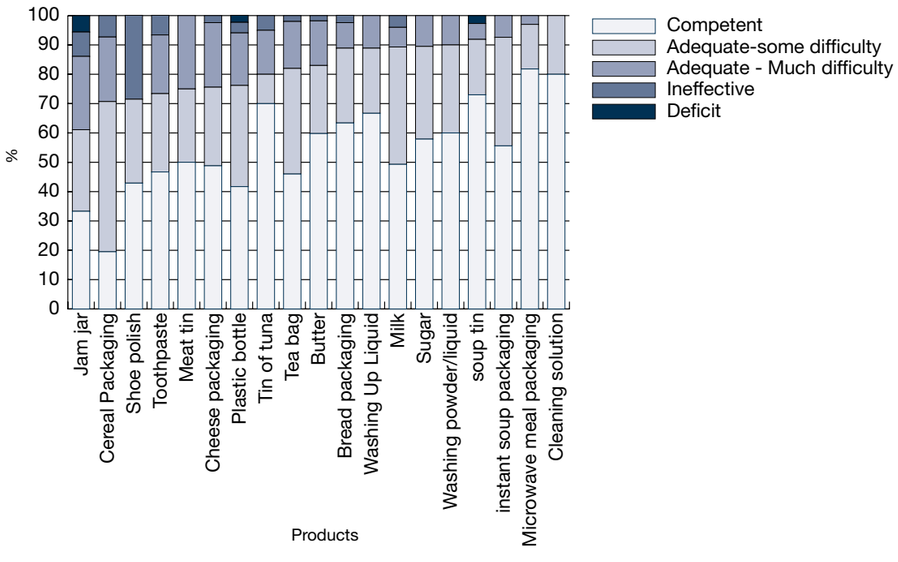
APPENDIX 6

The motor score graphs of sorted categorised products

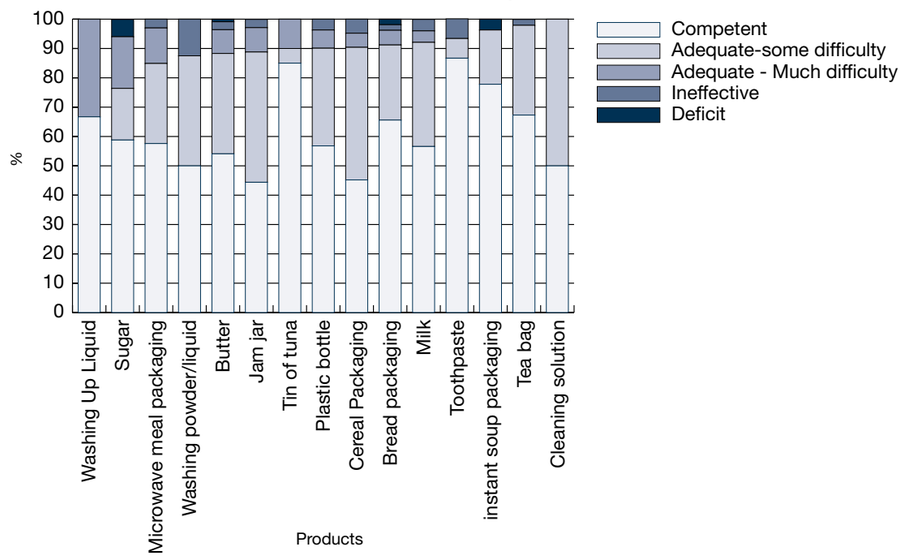




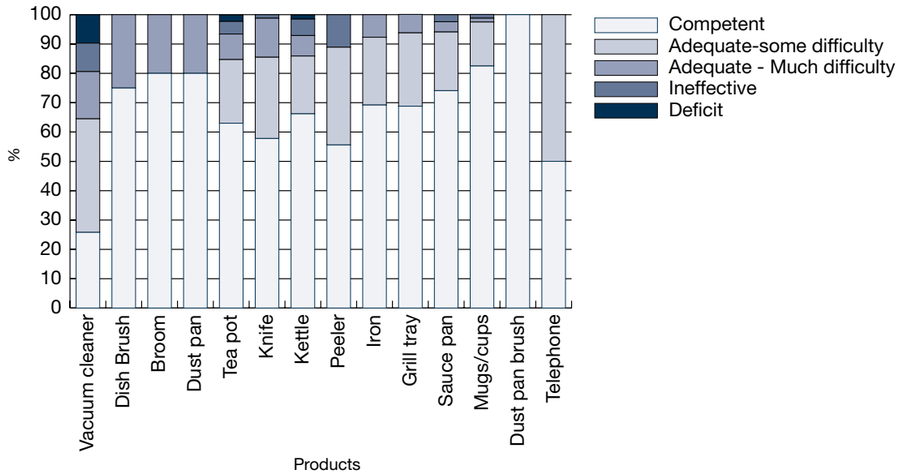
Gripping for packaging products sorted by combined scores in two groups for the best and worst products



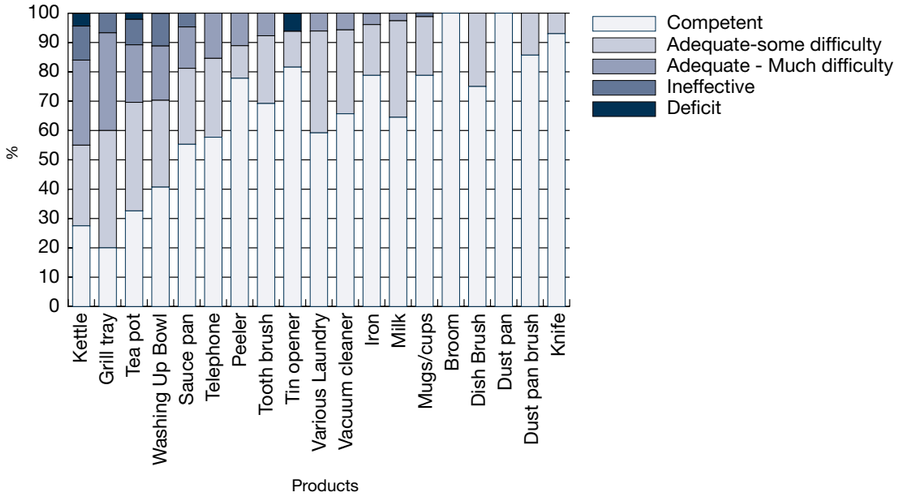
Transporting for packaging products sorted by combined scores in two groups for the best and worst products

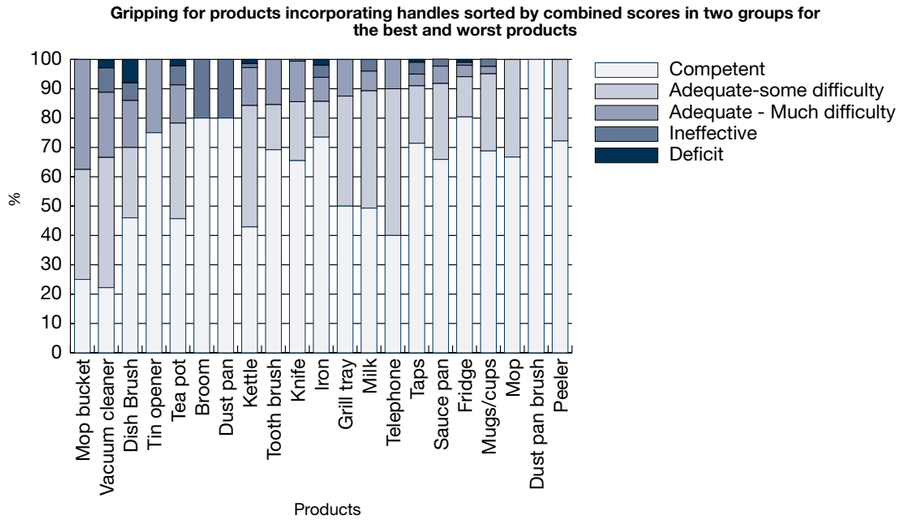


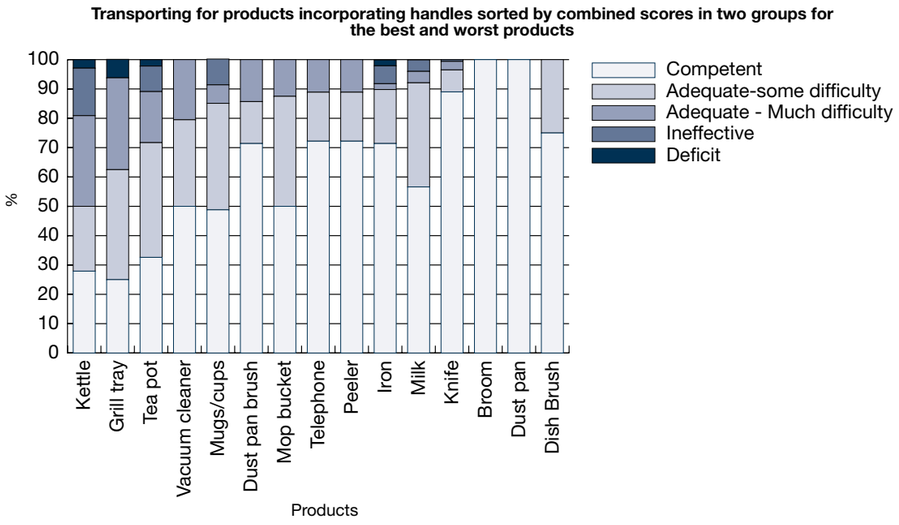
Manipulation for products incorporating handles sorted by combined scores in two groups for the best and worst products

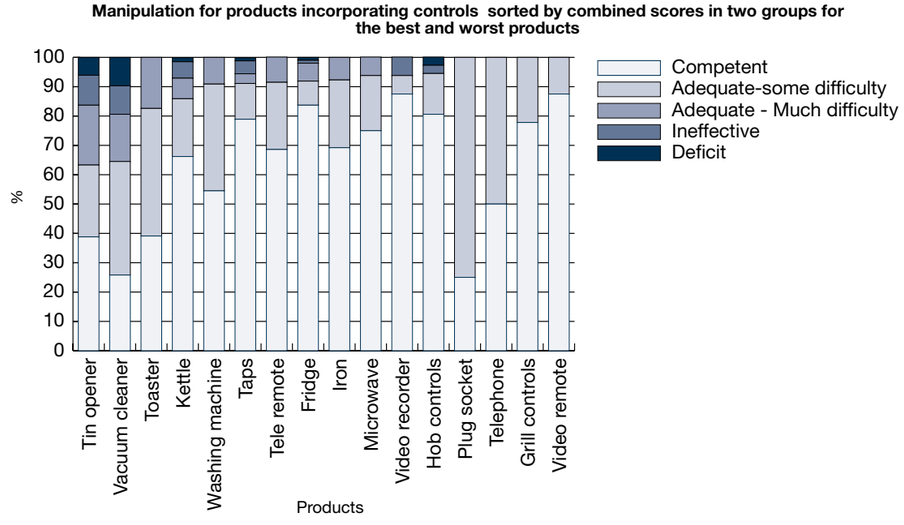


Lifting for products incorporating handles sorted by combined scores in two groups for the best and worst products




Gripping for products incorporating handles sorted by combined scores in two groups for the best and worst products
%
Products
Competent
Adequate-some difficulty
Adequate - Much difficulty
Ineffective
Deficit
Mop bucket
Vacuum cleaner
Dish Brush
Tin opener
Tea pot
Broom
Dust pan
Kettle
Tooth brush
Knife
Iron
Grill tray
Milk
Telephone
Taps
Sauce pan
Fridge
Mugs/cups
Mop
Dust pan brush
Peeler


Transporting for products incorporating handles sorted by combined scores in two groups for the best and worst products
%
Products
Competent
Adequate-some difficulty
Adequate - Much difficulty
Ineffective
Deficit
Kettle
Grill tray
Tea pot
Vacuum cleaner
Mugs/cups
Dust pan brush
Mop bucket
Telephone
Peeler
Iron
Milk
Knife
Broom
Dust pan
Dish Brush


Manipulation for products incorporating controls sorted by combined scores in two groups for the best and worst products
%
Products
Competent
Adequate-some difficulty
Adequate - Much difficulty
Ineffective
Deficit
Tin opener
Vacuum cleaner
Toaster
Kettle
Washing machine
Taps
Tele remote
Fridge
Iron
Microwave
Video recorder
Hob controls
Plug socket
Telephone
Grill controls
Video remote

APPENDIX 7

Motor and process factor definitions

Manipulate refers to the fine hand and finger operations needed to operate or generally use the product eg turning cooker controls, using a remote control, using microwave controls, opening certain types of packaging.

- 'Competent' rating should be given if the subject can manipulate the product with no problems.
- 'Adequate – some difficulty' rating should be given if the subject can manipulate the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- 'Adequate – much difficulty' rating should be given if the subject can manipulate the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- 'Ineffective' rating should be given if the subject attempts to manipulate the product with some relevant success but with an ineffective outcome.
- 'Deficit' rating should be given if the subject attempts to manipulate the product without success.

Lift refers to lifting products such as kettles, packaging etc without ambulating; and pertains to having enough strength to lift objects.

- 'Competent' rating should be given if the subject can lift the product with no problems.
- 'Adequate – some difficulty' rating should be given if the subject can lift the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- 'Adequate – much difficulty' rating should be given if the subject can lift the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- 'Ineffective' rating should be given if the subject attempts to lift the product with some relevant success but with an ineffective outcome.
- 'Deficit' rating should be given if the subject attempts to lift the product without success.

Grip refers to pinching and grasping in order to grasp handles, to open fastenings and containers, or to remove coverings; relates to the effectiveness of pinch and grip (strength).

- 'Competent' rating should be given if the subject can grip the product with no problems.
- 'Adequate – some difficulty' rating should be given if the subject can grip the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- 'Adequate – much difficulty' rating should be given if the subject can grip the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- 'Ineffective' rating should be given if the subject attempts to grip the product with some relevant success but with an ineffective outcome.

- 'Deficit' rating should be given if the subject attempts to grip the product without success.

Transports refers to carrying objects while ambulating or moving from one place to another (eg in a wheelchair) and pertains to the physical capacity to gather.

- 'Competent' rating should be given if the subject can transport the product with no problems.
- 'Adequate – some difficulty' rating should be given if the subject can transport the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- 'Adequate – much difficulty' rating should be given if the subject can transport the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- 'Ineffective' rating should be given if the subject attempts to transport the product with some relevant success but with an ineffective outcome.
- 'Deficit' rating should be given if the subject attempts to transport the product without success.

Reaches refers to stretching or extending the arm, and, when appropriate, the trunk to grasp or place the objects that are out of reach. Pertaining to the ability to effectively reach to the extent necessary in order to obtain objects or whether the aspects of the product are reachable for the subject, eg grill trays on cookers, shelves of the refrigerator, cooker controls etc.

- 'Competent' rating should be given if the subject can reach the product/relevant aspects of the product with no problems.
- 'Adequate – some difficulty' rating should be given if the subject can reach the product/relevant aspects of the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- 'Adequate – much difficulty' rating should be given if the subject can reach the product/relevant aspects of the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- 'Ineffective' rating should be given if the subject attempts to reach the product/relevant aspects of the product with some relevant success but with an ineffective outcome.
- 'Deficit' attempts to reach the product/relevant aspects of the product without success.

Sequences refers to the use of components or controls of the product in a logical order. (May not be applicable to all products) e.g. turning on/off cooker at appropriate times.

- 'Competent' rating should be given if the subject can sequence the use of the components of the product, within the task, with no problems.
- 'Adequate – some difficulty' rating should be given if the subject can sequence the use of the product/components of the product, within the task, adequately but with some difficulty and/or one or two errors and/or quite slowly.

- ‘Adequate – much difficulty’ rating should be given if the subject can sequence the use of the product/components of the product, within the task adequately but with much difficulty and/or many errors and/or extremely slowly.
- ‘Ineffective’ rating should be given if the subject attempts to sequence the use of the product/components of the product, within the task, with some relevant success but with an ineffective outcome.
- ‘Deficit’ rating should be given if the subject attempts to sequence the product/components of the product, within the task, without success.

Notices/responds refers to seeing and responding to feedback from the products involved, e.g. light on the iron that indicated temperature has been reached.

- ‘Competent’ rating should be given if the subject can notice (and respond to) relevant aspects of the product with no problems.
- ‘Adequate – some difficulty’ rating should be given if the subject can notice (and respond to) relevant aspects of the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- ‘Adequate – much difficulty’ rating should be given if the subject can notice (and respond to) relevant aspects of the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- ‘Ineffective’ rating should be given if the subject can notice (and respond to) some aspects of the product but not all of those that are relevant.
- ‘Deficit’ rating should be given if the subject fails to notice (and respond to) relevant aspects of the product

Uses refers to satisfactorily understanding and using the products as required by the task sheet.

- ‘Competent’ rating should be given if the subject can understand the use of the product with no problems.
- ‘Adequate – some difficulty’ rating should be given if the subject can understand the use of the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- ‘Adequate – much difficulty’ rating should be given if the subject can understand the use of the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- ‘Ineffective’ rating should be given if the subject attempts to understand the use of the product with some relevant success but with an ineffective outcome.
- ‘Deficit’ rating should be given if the subject attempts to use the product without success.

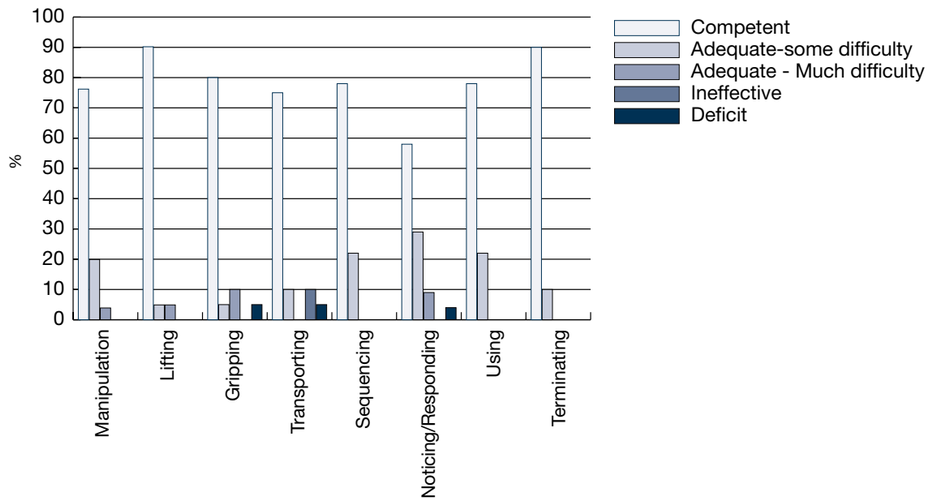
Terminates refers to giving a clear indication that it is known that the product has fulfilled it’s purpose and is longer needed.

- ‘Competent’ rating should be given if the subject can terminate use of the product with no problems.
- ‘Adequate – some difficulty’ rating should be given if the subject can terminate use of the product adequately but with some difficulty and/or one or two errors and/or quite slowly.
- ‘Adequate – much difficulty’ rating should be given if the subject can terminate use of the product adequately but with much difficulty and/or many errors and/or extremely slowly.
- ‘Ineffective’ rating should be given if the subject fails to terminate use of the product within an acceptable time frame.
- ‘Deficit’ rating should be given if the subject fails to terminate use of the product (until specifically told to do so by the examiner).

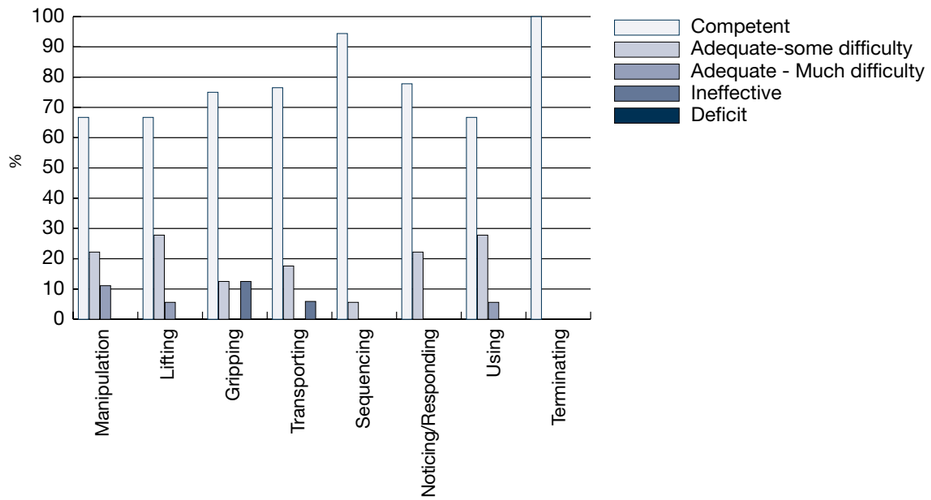
At the bottom of the product sheet is a comments box. This is for any other relevant information regarding the product to be noted. This can include more specific information about the nature of the problem with the product and when it occurs etc.

A comparison of the difficulties experienced between two age groups, as judged by motor and process scores in a sample of products

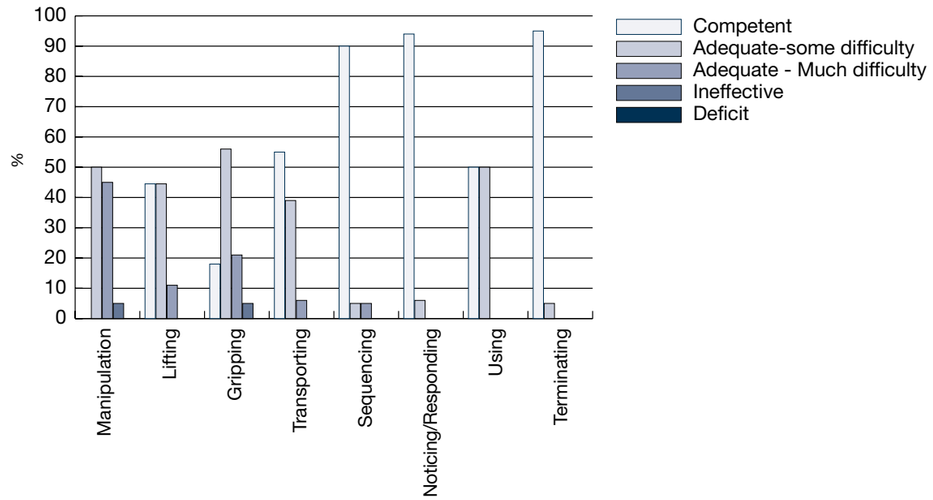
Iron - motor and process scores (59 years and under) (n=21)



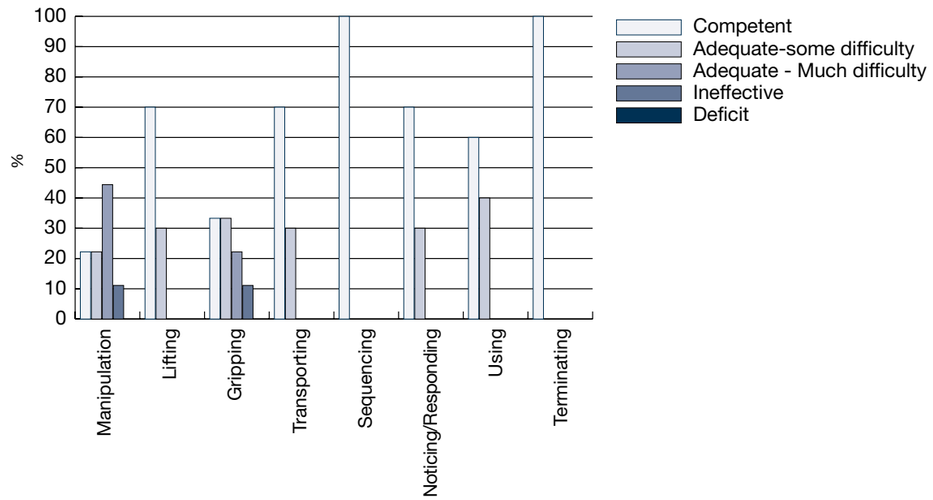
Iron - motor and process scores (60 years and over) (n=18)



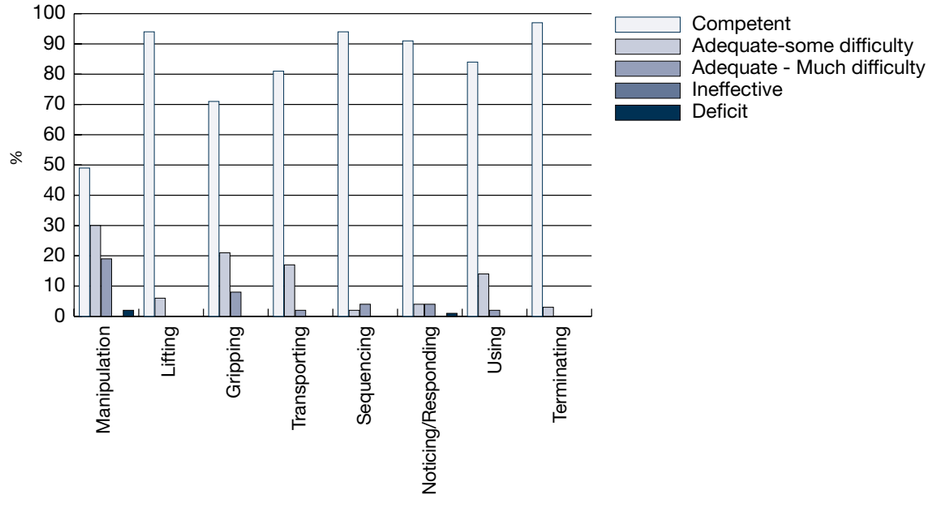
Cereal packaging - motor and process scores (59 years and under) (n=18)



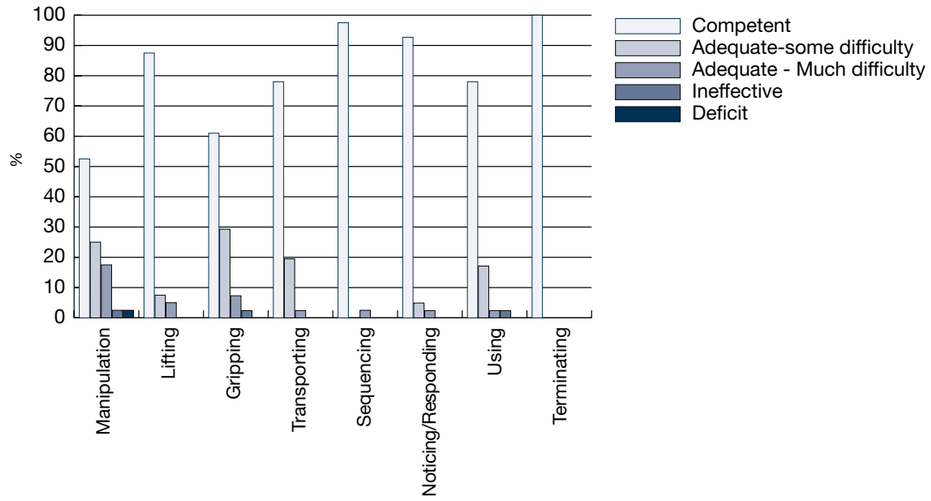
Cereal packaging - motor and process scores (60 years and over) (n=10)



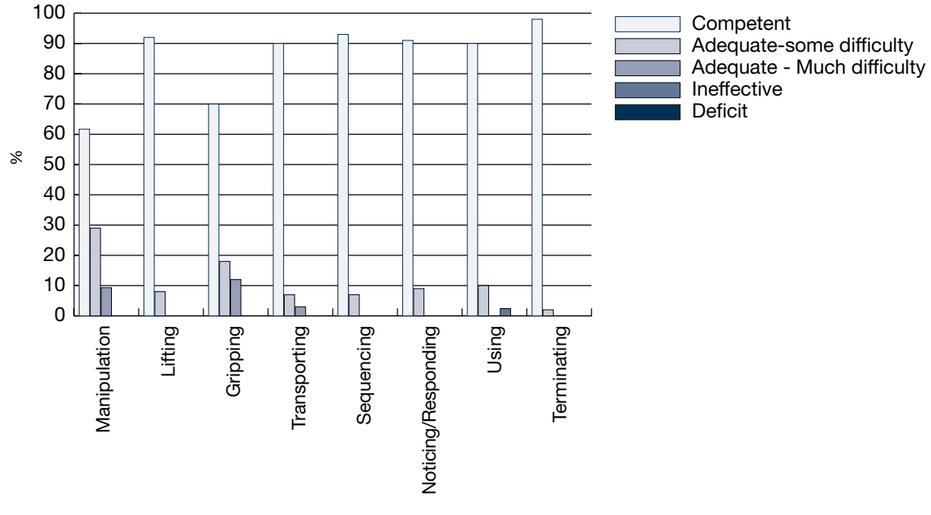
Bread packaging - motor and process scores (59 years and under) (n=56)



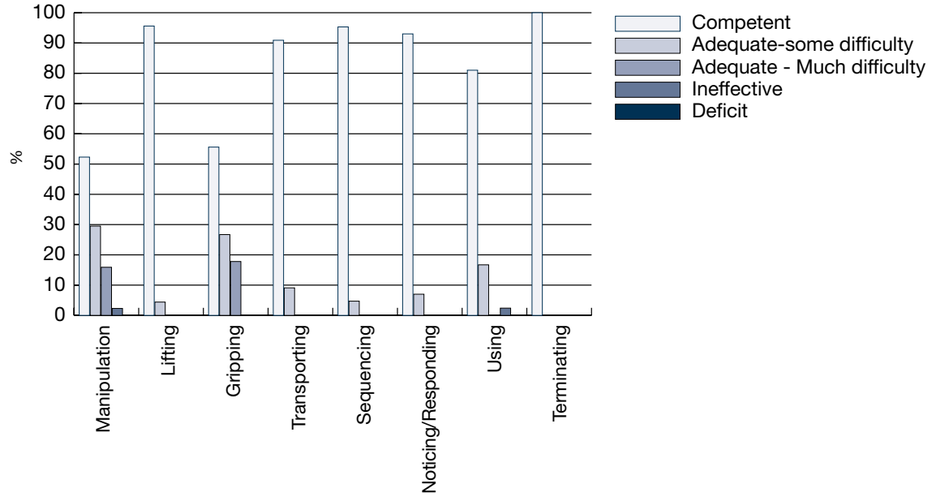
Bread packaging - motor and process scores (60 years and over) (n=43)



Knife packaging - motor and process scores (59 years and under) (n=52)

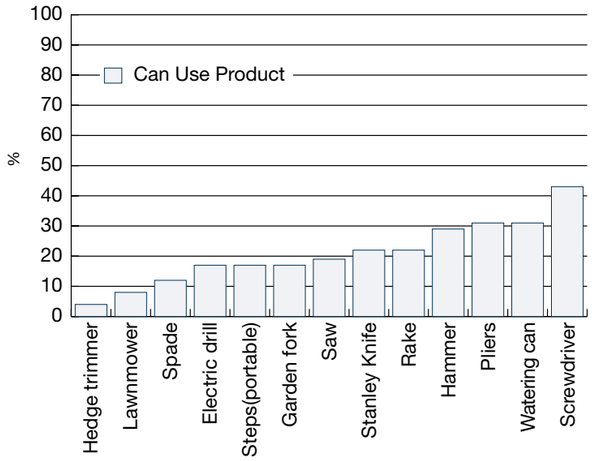


Knife packaging - motor and process scores (60 years and over) (n=43)



APPENDIX 9

The use of DIY and gardening products by disabled people (n=48)



APPENDIX 10

Products that caused the most difficulty for disabled users

1.0 Introduction

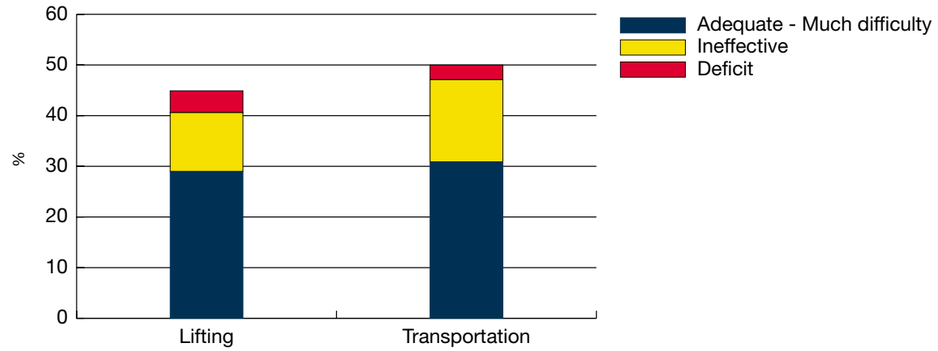
The following section deals with all of the products used in the study that gave difficulties as earlier described to proportions greater than 20% with any of the 4 motor factors measured.

Each product that reached the threshold is shown with the following information:

- The motor factors that produced results above the defined threshold
- The comments made by the participants

2.0 Kettle

Motor and process scores for kettles



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	7.0	29.0	12.9	30.9
Ineffective	5.6	11.6	1.4	16.2
Deficit	1.4	4.3	1.4	2.9
Totals	**14.0**	**44.9**	**15.7**	**50.0**

Summary of comments for kettles (n=82)

The following lists the most frequent comments made by participants and their incidence

- uses a jug to fill the kettle to avoid carrying (n=15)
- keeps water at a level that is not too heavy to lift (n=25)
- difficulty lifting when filled (n=24)
- problems pouring the filled kettle (n=32)
- leans kettle on front edge when pouring (n=9)
- slides kettle along the work surface to avoid carrying (n=7)
- uses two hands to lift and pour (n=13)

2.0.1 Conclusions for kettles

Implications for measuring capabilities and capacities of disabled people

The motor and process factors that exceeded the defined threshold were lifting and transporting. This was emphasised by the comments that were recorded during the experiment. All of the comments that were recorded refer in some respect to the participants reducing the weight of the kettle to make it easier to carry, or coping strategies that make pouring from the kettle easier. A wide selection of kettle designs was used during the study, suggesting that a radical design solution is required to overcome the problems that were encountered in lifting and transporting kettles.

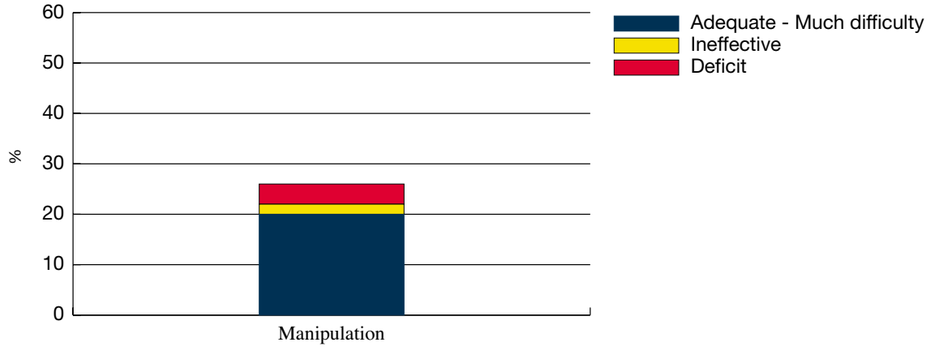
Although there is good ergonomics data on handle design for products such as kettles and teapots for use by the disabled population, the applicability of this data to the disabled population has not been verified. Therefore the handle diameters, cross sectional profiles, lengths, and material characteristics of handle design should be investigated with reference to the disabled population. The weight that can be supported when using these different handle configurations should also be measured.

Tentative design implications

As regards the design of the kettle, the comments related to reducing the weight of kettle to make it easier to carry, or other strategies that make pouring from the kettle easier. Interestingly, the gripping of the kettle was not cited specifically as a problem which is perhaps consistent with the fact that most kettles have a large gripping diameter, are fairly long (giving space for the fingers) and provide clearance between the handle and the body of the kettle.

3.0 Tea bag packaging

Motor and process scores for tea bag packaging



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	20	0	16	0
Ineffective	2	0	2	2.04
Deficit	4	0	0	0
Totals	**26**	**0**	**18**	**2.04**

Summary of comments for tea bag packaging (n=53)

The following lists the most frequent comments made by participants and their incidence.

- difficulty in locating the red tea strip (n=21)
- difficulties with pulling the start tab of the red tea strip (n=16)
- used scissors to open packaging (n=12)
- used knife to open packaging (n=12)
- used teeth to open packaging (n=2)

3.0.1 Conclusions for tea bag packaging

Implications for measuring capabilities and capacities of disabled people

The main problem with tea bag packaging highlighted by the study was the initial opening of the packaging, and therefore motor factor manipulation. This was highlighted by the

manipulation score that has been shown to be over the defined threshold for products that are difficult to use in the graph above. For a large proportion of the sample the red tear strip was either impossible to locate or too hard too pull because of the small size of the tab. This lead to the participants using scissors, knives, or their teeth to open the packaging. These coping strategies have obvious safety implications.

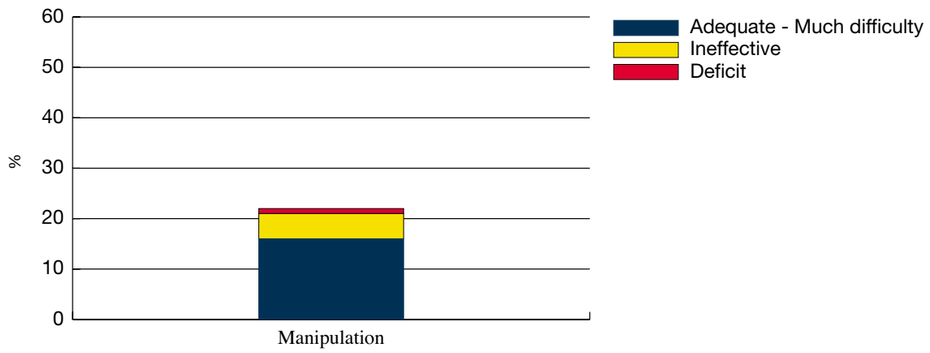
Tea bag packaging suggests that the fine manipulation and gripping capability of disabled people should be measured in any proposed next phase. This may involve determining a minimum size of pull-tab that will accommodate a defined proportion of the disabled population (90%).

Tentative design implications

For a large proportion of the sample the red tear strip was either impossible to locate or too hard too pull because of the small size of the tab. This lead to the participants using scissors, knives, or their teeth to open the packaging. These coping strategies have obvious safety implications. The tear strip tab needs to be easier to locate, larger and textured so that it is easier to hold and grip during use.

4.0 Milk packaging

Motor and process scores for milk packaging



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	16	2	7	5
Ineffective	5	0	4	4
Deficit	1	0	0	0
Totals	**22**	**2**	**11**	**9**

Summary of comments for milk packaging (n=82)

The following lists the most frequent comments made by participants and their incidence.

- uses teeth to pull on the seal tab (n=8)
- difficulty in pulling the tap and opening. Weak hands (n=24)
- four pinter, drags along the work surface to avoid carrying (n=5)
- pull tab too small to easily grip (n=32)
- prefers traditional milk bottles with foil tops (n=22)
- rests the front edge of the milk carton on the work surface when pouring (n=12)
- holds the pull tab and turns the bottle on the work surface to open (n=3)

4.0.1 Conclusions for milk packaging

Implications for measuring capabilities and capacities of disabled people

As shown in the graph above, the important motor and process factor was manipulation. This was emphasised by the comments that were recorded during the experiment. The problems with milk packaging centred around the initial opening in using the many seal mechanisms that are commonly used.

As with tea bag packaging, milk packaging suggests that the fine manipulation and gripping capability of disabled people should be measured in any proposed second phase. This may involve determining a minimum size of pull-tab that will accommodate a defined proportion of the disabled population (eg 90%).

Tentative design implications

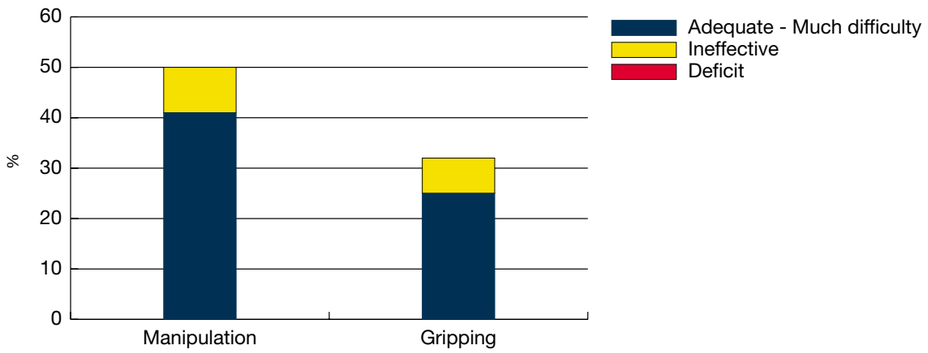
The numerous designs for milk packaging that are currently available have not improved the situation for disabled people, with many of the participants stating that they preferred foil topped milk bottles, as these are easy to open. The majority of the problems encountered centred around the size of the tab that must be pulled in order to open the milk, with small tabs producing gripping difficulties. This was emphasised by the use of teeth to pull the tab.

Therefore an obvious design solution is to increase the size of the pull-tab, and to use a textured surface on the tab to allow better gripping.

Many participants stated that they were unable to lift milk cartons holding more than one or two pints, and therefore lose the cost benefits of the larger containers.

5.0 Cereal packaging

Motor and process scores for cereal packaging



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	41	9	25	9
Ineffective	9	0	7	4
Deficit	0	0	0	0
Totals	**50**	**9**	**32**	**13**

Summary of comments for cereal packaging (n=44)

The following lists the most frequent comments made by participants and their incidence

- uses scissors to open the outer packaging (n=18)
- uses scissors to open the inner packaging (n=26)
- uses a knife to open the outer packaging (n=10)
- uses a knife to open the inner packaging (n=14)
- much difficulty in pulling open the inner packaging (n=14)
- has to rip off the lid (n=3)

5.0.1 Conclusions for cereal packaging

Implications for measuring capabilities and capacities of disabled people

As shown in the graph above, the important motor and process factors were manipulation and gripping. This was emphasised by the comments that were recorded during the experiment.

All of the comments refer to problems with one of these two motor factors. The results for the outer cereal packaging suggest that gap sizes for products where flaps must be opened should be investigated. The inner cereal packaging suggests that the force that can be applied in pulling apart two items should be measured.

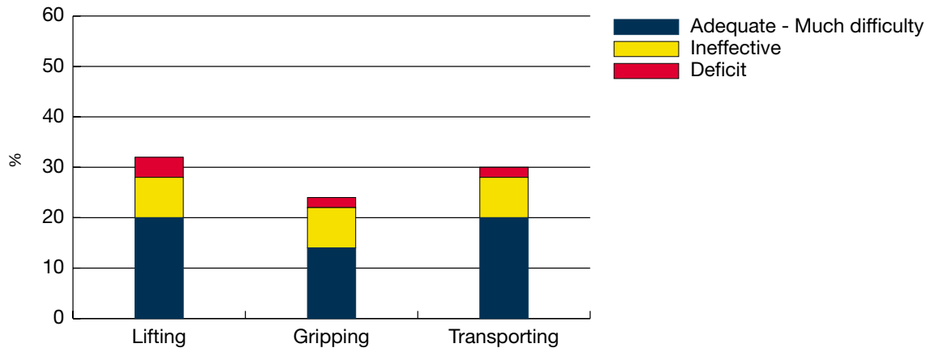
Tentative design implications

Opening the outer and inner packaging of cereal boxes caused difficulty for the participants. Many participants were unable to get fingers under the flap that opens the outer packaging, and resorted to using knives or scissors. The inner packaging was equally hard to open with the majority of participants being unable to pull apart the inner bag due to gripping difficulties, and again resorted to using the knives and scissors that caused safety problems.

As with the other food packaging items mentioned above, the opening mechanisms for cereal packaging were found to prohibit the proper use of the product. It should be made easier to get fingers under the flap at the top of the box, and integral tear strips that include a large textured pull-tab.

6.0 Tea pots

Motor and process scores for tea pots



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	12	20	14	20
Ineffective	4	8	8	8
Deficit	2	4	2	2
Totals	**18**	**32**	**24**	**30**

Summary of comments for a teapot (n=48)

The following lists the most frequent comments made by participants and their incidence

- uses a teapot with contrasting colours to the work surface to make it easier to see (n=2)
- does not use a tea pot as it is a safety hazard when pouring (n=4)
- difficulty pouring and lifting (n=23)
- difficulty transporting (n=29)

6.0.1 Conclusions for teapots

Implications for measuring capabilities and capacities of disabled people

As shown in the graph above, lifting, gripping and transporting of the teapot produced results above the defined threshold. The majority of the comments supported this conclusion.

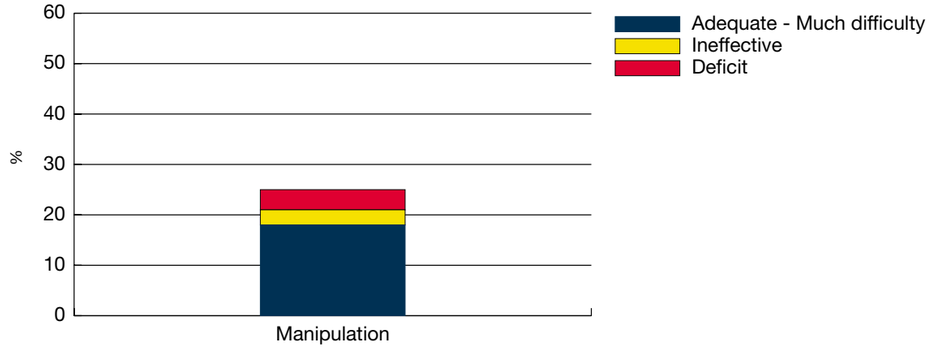
Although there is good ergonomics data on handle design for products such as kettles and teapots for use by the non-disabled population, the applicability of these data to the disabled population has not been verified. Therefore the handle diameters, cross sectional profiles, lengths, and material characteristics of handle design should be investigated with reference to the disabled population. The weight that can be supported when using these different handle configurations should also be measured.

Tentative design implications

The lifting and transporting of teapots and kettles have produced similar results in that these motor factors were above the threshold defined for products that are difficult to use. In addition, tea pots produced a gripping score above the defined threshold, whereas kettles did not. This indicates that the handle design of teapots is not as advanced as those of kettles. The application of good design and ergonomic principles to teapot handle configuration should improve the usability of tea pots by disabled people.

7.0 Bread packaging

Motor and process scores for bread packaging



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	18	3	9	6
Ineffective	3	0	3	2
Deficit	4	0	0	2
Totals	**25**	**3**	**12**	**10**

Summary of comments for bread packaging (n=189)

- difficulty in opening the small yellow seal (n=56)
- uses teeth to take off the seal (n=47)
- rips open the bag as the seal is too difficult to remove (n=22)
- uses sécateurs to cut open the packaging (n=1)
- uses scissors to cut open the packaging (n=58)
- uses a knife to cut open the packaging (n=26)

7.0.1 Conclusions for bread packaging

Implications for measuring capabilities and capacities of disabled people

As shown in the graph above manipulation of bread packaging produced results above the defined threshold. The majority of the comments supported this conclusion with most referring to the removal of the yellow seal tag. This suggests that the force that can be

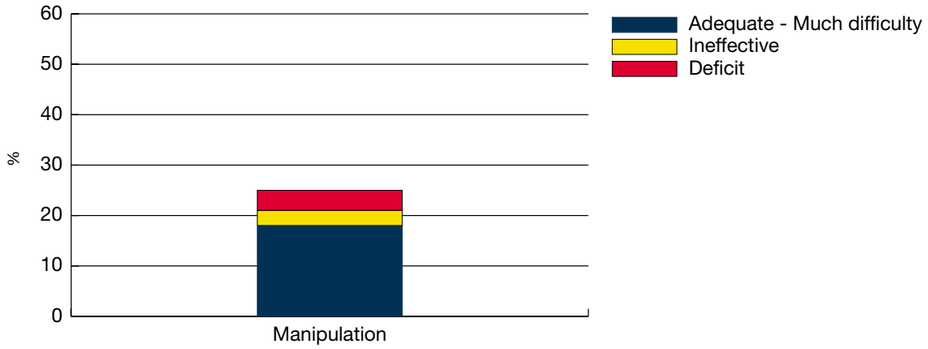
applied in pulling apart two items should be measured. Also the fine manipulation and gripping capability of disabled people should be measured in any proposed second phase. This may involve determining a minimum size of pull-tab that will accommodate a defined proportion of the disabled population (eg 90%).

Tentative design implications

As with the milk packaging and tea bag packaging, the pull-tabs used on food packaging need to be larger and easier to grip. Alternatively, other methods of opening which are easy to use should be designed.

8.0 Margarine containers

Motor and process scores for margarine container



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	18	4	14	8
Ineffective	4	0	3	2
Deficit	2	0	1	1
Totals	**24**	**4**	**18**	**11**

Summary of comments for margarine packaging (n=131)

- prefers square container as better to grip, more stable (n=3)
- uses knife to open packaging (n=5)
- some difficulty due to lack of feeling in hands (n=7)
- problems opening (n=67)
- could not remove lid or foil seal, needed assistance (n=24)

8.0.1 Conclusions for margarine containers

Implications for measuring capabilities and capacities of disabled people

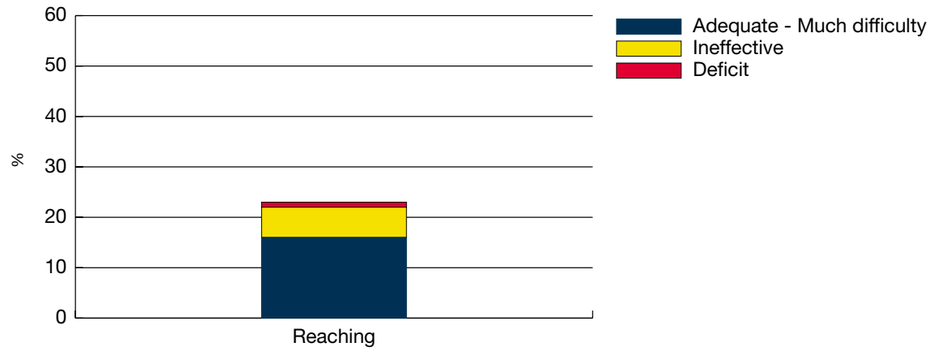
As shown in the graph above, the important motor factor was manipulation. This was emphasised by the comments that were recorded during the experiment. The fine manipulation and gripping capability of disabled people should be measured in any proposed second phase. This may involve determining a minimum size of pull-tab that will accommodate a defined proportion of the disabled population (eg 90%).

Tentative design implications

As with other food packaging items above, the gripping of tabs that are used for opening has been identified as a problem with margarine containers. Again, it is recommended that larger textured pull-tabs should be used, as other methods of opening explored.

9.0 Refrigerators

Motor and process scores for refridgerators



Rating	Proportion for each motor factor		
	Manipulation	Gripping	Reaching
Adequate - Much difficulty	7	5	16
Ineffective	1	1	6
Deficit	1	1	1
Totals	**9**	**7**	**23**

Summary of comments for refrigerators (n=121)

- difficulty in reaching into the bottom trays for vegetables (n=34)
- difficulties in reaching the middle and top shelves (n=32)
- uses a small fridge mounted on the work surface to make it easier to reach (n=12)
- leans on the door for support whilst reaching into the fridge (n=15)

Conclusions for refrigerators

Implications for measuring capabilities and capacities of disabled people

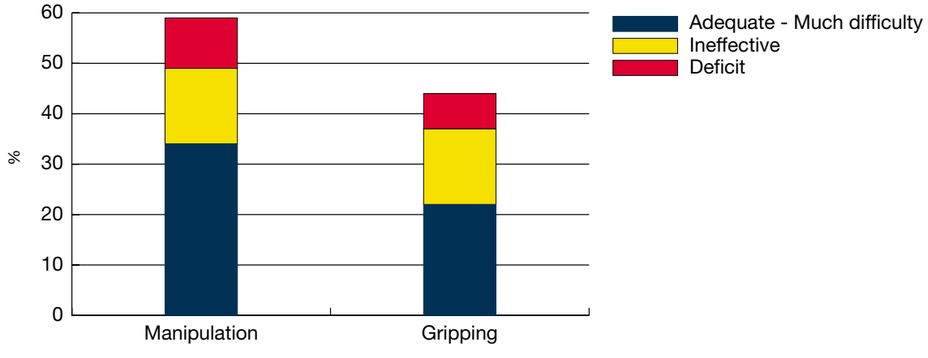
As shown in the graph above, the important motor factor was reaching. This was emphasised by the comments that were recorded during the experiment. The reaching capability of disabled people should be measured for reaching to both the front and side of the body. Also the gripping and manipulation ability of disabled people at various distances away from the body in order to determine if effectiveness of these two factors decreases with increased reaching distance.

Tentative design implications

The problem of reaching into a refrigerator is different depending on configuration. The participants had problems reaching to the bottom of single fridges, and the top and middle shelves of fridge freezers where the fridge is the top component. Modification of fridges to reduce shelf depth, or raising floor-mounted fridges should help to alleviate the problem.

10.0 Jam jars

Motor and process scores for jam jars



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	34	2	22	7
Ineffective	15	2	15	2
Deficit	10	0	7	0
Totals	**59**	**4**	**44**	**9**

Summary of comments for jam jars (n=41)

- difficulty removing the lid (n=30)
- uses a gadget to remove lid (n=21)
- has someone remove the lid first, then can open (n=12)

10.01 Conclusions for jam jars

Implications for measuring capabilities and capacities of disabled people

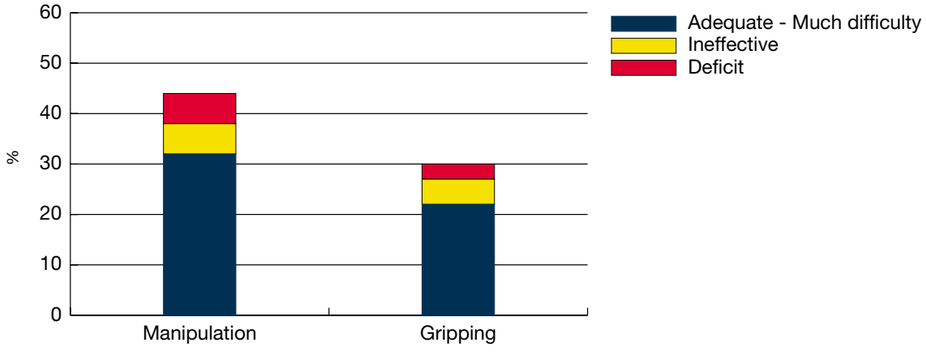
As shown in the graph above, the important motor factors were manipulation and gripping. This was emphasised by the comments that were recorded during the experiment. The problems with jam jars suggest the ability to apply contra-rotating forces for devices of different diameters should be measured.

Tentative design implications

At present jam jars present a clear problem for nearly 60% of the disabled population. The force required to open a jam jar for the first time should be reduced considerably. In addition, the jar lids should be made easier to grip using a combination of high friction materials and textured surfaces.

11.0 Plastic drink bottles

Motor and process scores for plastic drink bottle



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	32	3	22	10
Ineffective	6	0	5	3
Deficit	6	0	3	0
Totals	**44**	**3**	**30**	**13**

Summary of comments for plastic drink bottles (n=96)

- difficulty removing the cap (n=60)
- uses a gadget to remove cap (n=35)
- has someone remove the cap first, then can open (n=21)
- difficulty gripping larger bottles (n=34)
- difficulty carrying larger bottles (n=18)

11.01 Conclusions for plastic drink bottles

Implications for measuring capabilities and capacities of disabled people

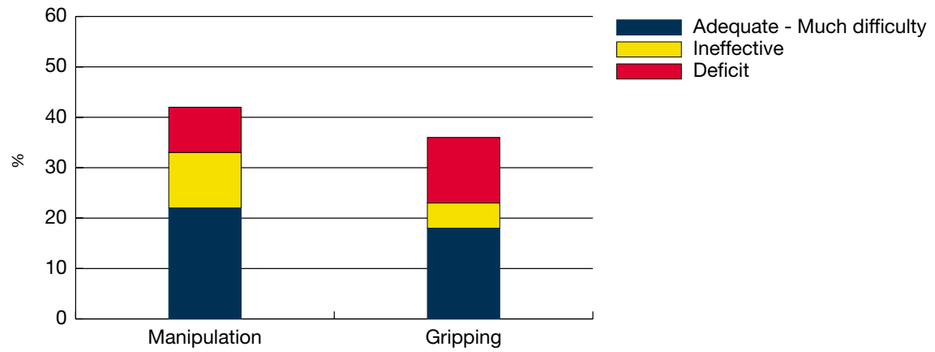
As shown in the graph above, the important motor factors were manipulation and gripping. This was emphasised by the comments that were recorded during the experiment. As with jam jars, plastic drink bottles suggest the ability to apply contra-rotating forces for devices of different diameters should be measured. Also the optimal diameter of devices that must be twisted should be investigated by testing a range of diameters and employing different surface characteristics.

Tentative design implications

Opening the cap of the plastic drink bottles produced a high level of difficulty for the participants. Nearly two thirds of the sample had some difficulty in removing the bottle cap and over a third of the sample used some sort of assistive device to do so. Bottle caps should be made easier to grip using a combination of high friction materials and textured surfaces. The force required to open a jam jar for the first time should be reduced considerably.

12.0 Manual tin opener

Motor and process scores for manual tin opener



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	22	0	18	2
Ineffective	11	0	5	2
Deficit	9	7	13	9
Totals	**42**	**7**	**36**	**13**

Summary of comments for manual tin openers (n=58)

- great manipulation difficulty (n=24)
- cannot apply enough force to turn the handle (n=8)
- cannot apply enough force to pierce tin lid (n=5)
- cannot use as requires both hands to operate (n=2)

12.0.1 Conclusions for manual tin openers

Implications for measuring capabilities and capacities of disabled people

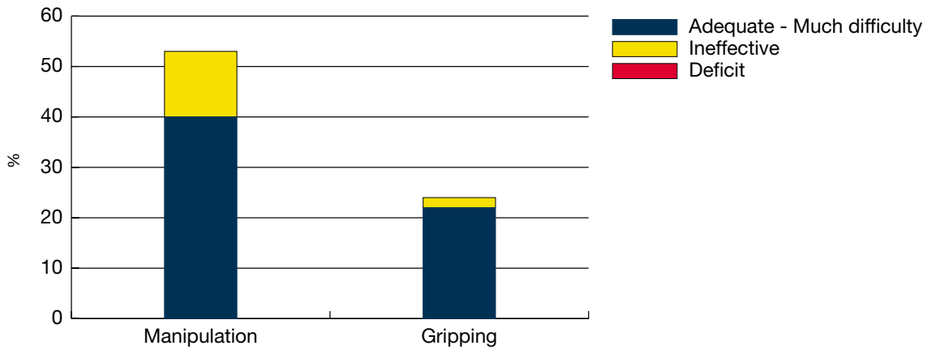
As shown in the graph above, the important motor factors were manipulation and gripping. This was emphasised by the comments that were recorded during the experiment. For products such as tin openers, the ability to push two handles together, in combination with the optimal handle profile for this task should be investigated.

Tentative design implications

Again the problem of the force levels required to use a device or open food packaging has arisen. The combination of rating scale scores data and the comments made have shown that applying enough gripping force to close the tin opener handles and then piercing the tin lid is of great difficulty for many participants. The force required to then, turn the tin opener handle and open the tin is also prohibitive. Tin opener mechanisms are required that reduce these force levels.

13.0 Cheese packaging

Motor and process scores for cheese packaging



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	40	0	22	2
Ineffective	13	2	2	0
Deficit	0	0	0	2
Totals	**53**	**2**	**24**	**4**

Summary of comments for cheese packaging (n=45)

- uses scissors to cut open the packaging (n=19)
- uses a knife to open the packaging (n=33)
- slices straight through the packaging and into the cheese (n=12)
- uses teeth to open (n=3)

13.0.1 Conclusions for cheese packaging

Implications for measuring capabilities and capacities of disabled people

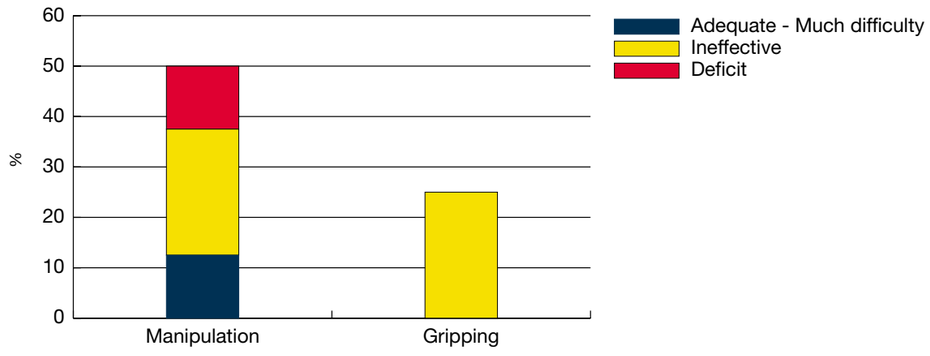
As shown in the graph above, the important motor factors were manipulation and gripping. This was emphasised by the comments that were recorded during the experiment. As the cheese packaging required nearly all of the participants to use a device to cut the packaging, it is suggested that the participants could not grip the packaging and pull it apart. Therefore, as with inner cereal packaging, the force that can be applied in pulling apart two items should be measured.

Tentative design implications

All of the participants who used the cheese packaging had to use some form of cutting device to open cheese packaging. In all cases the strategies used by the participants involved safety implications for the participants. The incorporation of integral tear strips used with the pull-tabs as discussed above would produce cheese packaging that requires no additional devices to be used in order to open it.

14.0 Shoe polish tin

Motor and process scores for shoe polish tin



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	12.5	0	0	0
Ineffective	25	0	25	12.5
Deficit	12.5	0	0	0
Totals	**50**	**0**	**25**	**12.5**

14.0.1 Conclusions for shoe polish tins

Implications for measuring capabilities and capacities of disabled people

As shown in the graph above, the important motor factors were manipulation and gripping. Therefore the optimal diameter of devices that must be twisted should be investigated by testing a range of diameters. Additionally, surface characteristic should be measured.

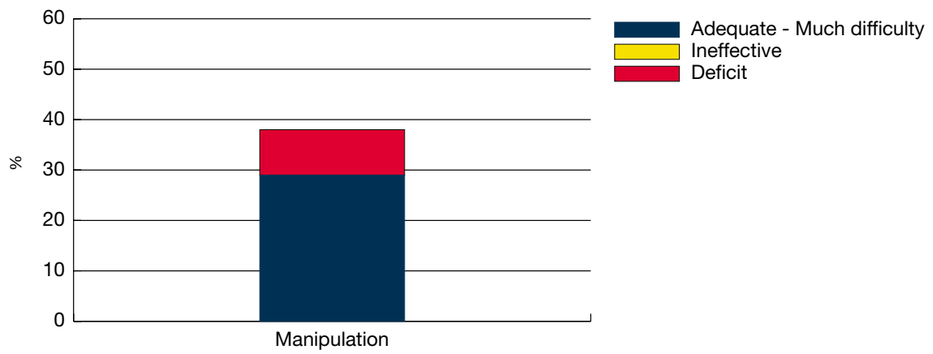
Tentative design implications

The traditional shoe polish can design requires a relatively high level of strength and manipulation ability. It is recognised that many alternative forms of shoe polish packaging are on the market which are probably easier to use by disabled people. If the traditional tin of shoe polish is to be aimed at disabled people a complete redesign of this product packaging is required.

A small number of participants used their own shoe polish after failing to open the traditional tin design. This was generally of the liquid type contained in roller ball bottles. The use of these designs presented few problems.

15.0 Instant drink packaging

Motor and process scores for instant drink packaging



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	29	6	15	6
Ineffective	0	0	3	0
Deficit	9	0	0	3
Totals	**38**	**6**	**18**	**9**

Summary of comments for instant drink packaging (n=34)

- difficulty locating the 'rip' notch (n=12)
- difficulty in tearing the packaging (n=15)

15.0.1 Conclusions for instant drink packaging

Implications for measuring capabilities and capacities of disabled people

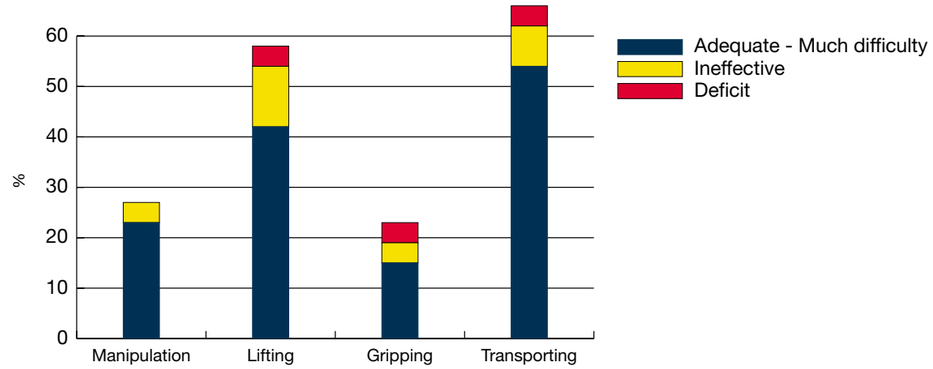
As shown in the graph above, the important motor factor was manipulation. This was emphasised by the comments that were recorded during the experiment. Instant drink sachets suggest the ability to apply bi-directional ripping forces should be measured.

Tentative design implications

The paper sachet design of the instant drink packaging used in the study caused problems for the participants because locating the 'rip' notch was found the be difficult. Also propagating the tear in the sachet was found to be difficult.

16.0 Ironing boards

Motor and process scores for ironing boards



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	23	42	15	54
Ineffective	4	12	4	8
Deficit	0	4	4	4
Totals	**27**	**58**	**23**	**65**

Summary of comments for ironing boards (n=28)

- difficulty getting close enough to the ironing board when using a wheelchair (n=11)
- difficulty unfolding the ironing board due to the weight (n=15)
- too heavy and awkward to carry (n=18)
- irons on a different surface as cannot use an ironing board (n=10)

16.0.1 Conclusions for ironing boards

Implications for measuring capabilities and capacities of disabled people

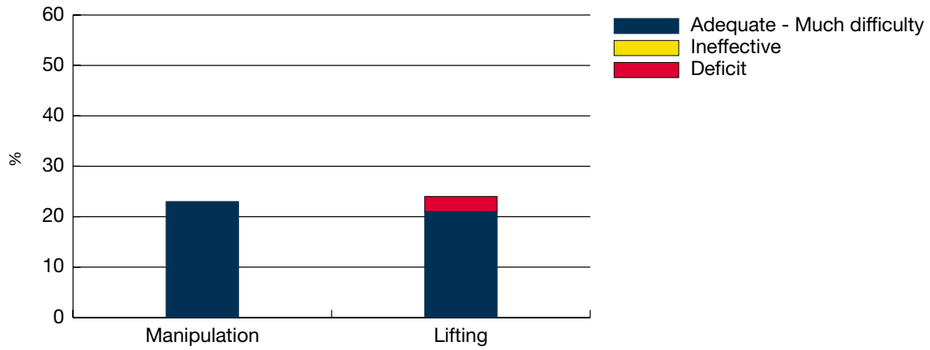
As shown in the graph above, the important motor factors were manipulation, lifting, gripping, and transporting. This was emphasised by the comments recorded during the experiment. The main implication in terms of measurement is that of the weight of the device. The other factors that can be improved upon with good design principles, as discussed below. Therefore the ability of disabled people to carry items of different weights and weight distribution characteristics should be measured.

Tentative design implications

The motor factors that have passed the defined threshold highlight a number of design implications in combination with the comments that have been recorded. Unfolding the ironing board caused problems in terms of supporting the weight of the device whilst manipulating the release handle and unfolding the legs. When the ironing board has been unfolded many wheelchair users found it difficult to get close enough to the ironing board due to the configuration of the legs. Finally transporting the ironing board was found to be difficult due to the weight and the awkward shape. The problems that have been encountered suggest designing a lighter ironing board that incorporates an easy opening mechanism with legs that allow a knee hole for wheelchair users.

17.0 Microwave meal packaging

Motor and process scores for microwave meal packaging



Rating	Proportion for each motor factor	
	Manipulation	Lifting
Adequate - Much difficulty	23	21
Ineffective	0	0
Deficit	0	3
Totals	**23**	**24**

Summary of comments for microwave packaging (n=43)

- difficulty opening outer carton (n=24)
- difficulty in reading instructions (n=8)
- difficulty in removing from the microwave due to heat (n=12)
- uses a knife to open outer carton (n=15)
- food tray looses rigidity when hot (n=17)
- difficulty removing the plastic film (n=12)

17.0.1 Conclusions for microwave packaging

Implications for measuring capabilities and capacities of disabled people

As shown in the graph above, the important motor factors were manipulation and lifting. This was emphasised by the comments recorded during the experiment. The outer microwave meal required the user to insert the finger under a flap. Since the space available was often too small finger sizes should be investigated.

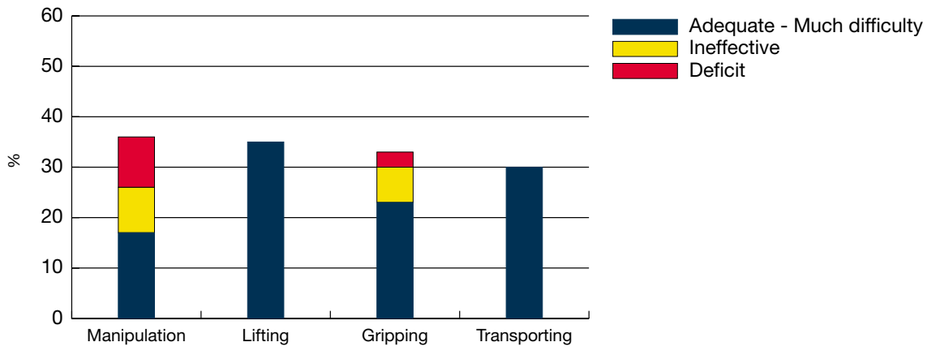
Tentative design implications

As with the cereal packaging participants found lifting the flap of the outer carton difficult. Again many participants used an assistive device. The opening mechanisms for the outer carton of microwave meal packaging are prohibitive to the use of the product. It should be made easier to get fingers under the flap of the box. After the food has been cooked in the microwave many participants found that the food tray looses it's rigidity making it harder to remove the meal from the microwave. This problem needs to be solved using more suitable materials for the food tray. The plastic film that covers the food tray was found to cause difficulty when the participants tried to remove it.

18.0 Vacuum cleaner

Over 59s

Motor and process scores for vacuum cleaner



Rating	Proportion for each motor factor			
	Manipulation	Lifting	Gripping	Transporting
Adequate - Much difficulty	17	35	23	30
Ineffective	9	0	7	0
Deficit	10	0	3	0
Totals	**36**	**35**	**33**	**30**

Summary of comments for vacuum cleaner (n=38)

- cannot lift and so pushes along the floor (n=12)
- chose a special lightweight cleaner for easier carrying(n=9)
- difficulty in manipulating the cord (n=7)
- difficulty in reaching when using (n=15)

- difficulty with an upright vacuum cleaner with the vertical release mechanism (n=4)

18.0.1 Conclusions for vacuum cleaner

Implications for measuring capabilities and capacities of disabled

As shown in the graph above, the important motor factors were manipulation, lifting, gripping, and transporting. This was emphasised by the comments recorded during the experiment. Vacuum cleaners suggest that the ability of disabled people to carry items of different weights and weight distribution characteristics should be measured. This should be done in combination with an investigation of the handle characteristics as discussed for kettles and teapots.

Tentative design implications

The information above has shown that participants had difficulty using vacuum cleaners relating to four of the motor factors. Participants had most difficulty with the weight of vacuum cleaners, which relates to lifting and transporting of the device. Therefore the overall weight of vacuum cleaners needs to be reduced. Participants also had difficulty manipulating the various mechanisms of vacuum cleaners, including the 'on' / 'off' switch and the device that releases the vacuum cleaner from the upright position. Manipulation of the cord after use also caused difficulty. Other, easier to use mechanisms need to be designed.

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Department of Trade and Industry
1 Victoria Street
London
SW1H 0ET

Carried out under contract by:
Robert Feeney Associates
Somerset House
26 Frederick Street
Loughborough
Leicestershire
LE11 3BJ

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