Scientific background for the basis of an international standard for easy-to-open packages

EASYOPENPACK 2006–2008

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Abstract:

Various characteristics of food packages are nowadays good, including their safety aspects. However, a novel problem has arisen: how to open the package easily. This is a challenge not only to consumers with reduced hand function, but it is common for all of us to face every now and then difficulties in opening packages. Especially adult consumers with reduced hand function, such as rheumatic or elderly people, or children are familiar with this issue. But what makes it easy to open a package, and what are the most critical factors for consumers in opening packages?

Nordic project ‘Scientific background for the basis of an international standard for easy-to-open packages’ (EASYOPENPACK) was aimed to answer these questions. The study was funded by NICe (Nordic Innovation Centre) (June 2006 -June 2008). The participants of the project were the research institutes (Danish Technological Institute, SIK The Swedish Institute for Food and Biotechnology, SP Technical Research Institute of Sweden and VTT Technical Research Centre of Finland), representatives from companies (Stora Enso Oyj, Tetra Pak Packaging Solutions AB and Nalato Cerbo AB), and associations (Finnish Rheumatism Association, Pakkausteknologia – PTR ry, Spenshult Reumatikersjukhus, Reumatikerförbundet, Den Norske Emballasjeforening and Emballage og Transports Medlemskreds). The aims of the Easyopenpack project were

- To screen physical qualifications and capabilities of consumers to open packages easily
- To search critical aspects in opening of different types of food packages
- To identify the most relevant method(s), which has (have) the necessary qualifications for providing the basis for the final test method
- To inform, interest and involve Nordic companies in product development work
- To collect scientific background information for the CEN (European Committee for Standardization) work for developing the test method.

When the capability of handling packages is concerned from a consumer point of view, there are several factors possibly influencing on the easiness to open packages. These are reduction in hand strength, in sensibility/sensitivity, in dexterity and in power grip, left or right-handed, co-ordination difficulties, shaking, pain, medical treatment visual capability, cognition and personality. Different movements and capabilities are required from consumers to fend from the opening process and handle successfully the packages. Forbidden physical paths are key pinch grip, use of power and twisting or rotation of wrist. Avoided physical paths are pulling, lifting and pushing by using power, whereas allowed is pulling with straight wrist, lifting and pushing with straight wrist and pressing.
A wide variety of different types of opening mechanisms of food packages exist. Eight commonly used food packages were selected for the experiments, and these eight packages represented very well the distribution among different types of food packages with various opening mechanisms.

The most critical attributes for evaluating the easiness to packages turned out to be

- visibility and clarity of the opening mechanism,
- keeping the grip from the opening mechanism,
- tightness and breakage of the opening mechanism,
- strength needed to open the package,
- need to use both hands in opening,
- rigidity and slipperiness of the packaging material,
- keeping the grip from the package,
- breakage of the package while opening, and
- degree of product staying inside the package after opening.

The mechanical test proved to be rather quick, easy and cheap to implement. It is also easily repeatable but does not imitate human action. Mechanical test measures only one dimension (strength), and necessitates specific equipment. By sensory assessment, a whole view of easiness to open packages can be formed. Sensory test imitates human action, and is easily repeatable. However, it is also rather time-consuming, expensive, and requires a well-trained panel. By a consumer study actual target groups can be imitated if recruitment criteria are well defined. Consumer test is culture-/ target group-dependent. It is also rather time-consuming, expensive, not easy to implement, and difficult to repeat if the procedure is not controlled. The recruitment of the test group is crucial, and usually a big test group (n~100) is needed. Simple and specific phrasing of the questions is critical for getting reliable results, and standardised and specified test design is essential.

Mechanical test is not recommended alone for a test due to the very narrow view of measuring easiness to open packages. Sensory and consumer tests could be usable. However, in sensory test the descriptive attributes mentioned in chapter 5.2 must always be checked prior the assessments. In addition, correct criteria (questions to be related to the critical sensory attributes) must be determined for the consumer test, and the consumer panel must be big and representative enough. The possibility to drastic bias exist, if the procedures to perform the tests are not well and extremely detailed defined.
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Executive summary

Various characteristics of food packages are nowadays good, including their safety aspects. However, a novel problem has arisen: how to open the package easily. This is a challenge not only to consumers with reduced hand function, but it is common for all of us to face every now and then difficulties in opening packages. Especially adult consumers with reduced hand function, such as rheumatic or elderly people, or children are familiar with this issue. But what makes it easy to open a package, and what are the most critical factors for consumers in opening packages?

The purpose of the project was

- To screen physical qualifications and capabilities of consumers to open packages easily
- To search critical aspects in opening different types of food packages
- To identify the most relevant method(s), which has (have) the necessary qualifications for providing the basis for the final test method
- To inform, interest and involve Nordic companies in product development work
- To create the scientific basis for the development of the test method for the European standard

The study has achieved this aim by

- Compiling background information through surveys
  - Review of demands of consumers for easy opening
  - Review of different types of packages and their opening mechanisms
  - Screening of possible test methods
- Participation in the CEN standardisation work
- Organising a workshop (Im)possible packaging on easiness to open packages, one of its aims being collection of needs related to easiness to open from enterprises
- Running several experimental studies
  - Mechanical tests
  - Sensory test
  - Consumer tests
- Networking with national and other Nordic contacts

Methods

Eight commonly used food packages representing various opening mechanisms were selected for the experiments. The easiness to open these packages was evaluated by several mechanical, sensory and consumer studies. Mechanical tests measuring force needed for opening the package was tested by three project partners. An analytical sensory evaluation was performed in two steps: a descriptor elicitation by a consumer panel by using the laddering technique, followed by sensory profiling by a trained sensory panel. Consumer studies were conducted as a focus group test and as three quantitative tests. In spite of briefly agreed testing procedures, the implementation of the consumer tests varied. Statistical multivariate analysis techniques were used in comparing and relating the results from different tests and in the qualification of the tests.
Main results and conclusions

When the capability of handling packages is concerned from a consumer point of view, there are several factors possibly influencing on the easiness to open packages. These are reduction in hand strength, in sensibility/sensitivity, in dexterity and in power grip, left or right-handed, co-ordination difficulties, shaking, pain, medical treatment visual capability, cognition and personality.

Different movements and capabilities are required from consumers to fend from the opening process and handle successfully the packages. Forbidden physical paths are key pinch grip, use of power and twisting or rotation of wrist. Avoided physical paths are pulling, lifting and pushing by using power, whereas allowed is pulling with straight wrist, lifting and pushing with straight wrist and pressing.

A wide variety of different types of opening mechanisms of food packages exist. Eight commonly used food packages were selected for the experiments, and these eight packages represented very well the distribution among different types of food packages with various opening mechanisms.

The most critical attributes for evaluating the easiness to packages turned out to be

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The mechanical test proved to be rather quick, easy and cheap to implement. It is also easily repeatable but does not imitate human action. Mechanical test measures only one dimension (strength), and necessitates specific equipment.

By sensory assessment, a whole view of easiness to open packages can be formed. Sensory test imitates human action, and is easily repeatable. However, it is also rather time-consuming, expensive, and requires a well-trained panel.

By a consumer study actual target groups can be imitated if recruitment criteria are well defined. Consumer test is culture-/ target group-dependent. It is also rather time-consuming, expensive, not easy to implement, and difficult to repeat if the procedure is not controlled. The recruitment of the test group is crucial, and usually a big test group (n~100) is needed. Simple and specific phrasing of the questions is critical for getting reliable results, and standardised and specified test design is essential.

Recommendations for continued studies and actions

Mechanical test is not recommended alone for a test due to the very narrow view of measuring easiness to open packages. Sensory and consumer tests could be usable. However, in sensory test the descriptive attributes mentioned in chapter 5.2 must always be checked prior the assessments. In addition, correct criteria (questions to be related to the critical sensory attributes) must be determined for the consumer test, and the consumer panel must be big and representative enough.
The possibility to drastic bias exist, if the procedures to perform the tests are not well and extremely detailed defined.

One of the objectives of this project was to create scientific basis for the development of the test method for the European CEN standard. This goal was achieved. The aim of this project was not to give recommendations or to set any acceptance criteria for assessing the easiness to open packages as this belongs to the standardisation committee. Active communication between the project group members and the standardisation group will aid in forwarding the results of this project to the knowledge of the corresponding CEN standardisation group.

In addition, the information gathered in this project will be distributed to companies aiding their product development and to consumers on national and Nordic levels. The Nordic rheumatic associations participating in this project have been very active on this field in their own projects, and this trend is continuing. Some national projects on the easiness to open packages as well as their usability more generally have been planned or are starting.
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Preface

This report covers results of the Nordic project ‘Scientific background for the basis of an international standard for easy-to-open packages’ (EASYOPENPACK) funded by NICe (Nordic Innovation Centre). Duration of the project was two years, from June 2006 until June 2008.

The aim of this Nordic project was to collect scientific background information for the European standardisation work. The scope for the standardisation work in CEN (the European Committee for Standardization) is to create criteria and test methods for evaluating the easiness to open consumer packages. In addition, the purpose of this project is to give guidance for companies to improve the ease of opening of consumer packages in order to increase easy and safe accessibility of the content.

The participants of the steering group of the project were the research institutes Danish Technological Institute, SIK The Swedish Institute for Food and Biotechnology, SP Technical Research Institute of Sweden and VTT Technical Research Centre of Finland. Apart from the steering group members, the project group also involved representatives from the companies Stora Enso Oyj, Tetra Pak Packaging Solutions AB and Nolato Cerbo AB, and associations Finnish Rheumatism Association, Pakkausteknologia – PTR ry, Spenshult Reumatikersjukhus, Reumatikerförbundet, Den Norske Emballasjeforeningen and The Member Circle of Packaging and Logistics (Emballage og Transports Medlemskreds). The contact person of the project in NICe was Mads Peter Schreiber. The project was coordinated by Lars-Göran Nilsson, SP (June 2006 – October 2007) and Raija-Liisa Heinö, VTT (November 2007 – June 2008).

The study was carried out by the research institutes of Danish Technological Institute, SIK and VTT Technical Research Centre of Finland, and by Stora Enso Oyj, Tetra Pak Packaging Solutions AB, Spenshult Reumatikersjukhus and Finnish Rheumatism Association. The authors of this report are Raija-Liisa Heinö from VTT Technical Research Centre of Finland, Annika Åström from SIK, Helle Antvorskov from Danish Technological Institute, Maria Mattsson from Spenshult Reumatikersjukhus and Sören Östergaard from Danish Technological Institute. Other partners contributing the content of the report are Noora Nylander from Stora Enso Oyj, Lars Svensson from Tetra Pak Packaging Solutions AB, Tita Ström from Finnish Rheumatism Association, Anne Arvola from VTT Technical Research Centre of Finland, and Terhen Järvi-Kääriäinen from Pakkausteknologia – PTR ry.

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1 Introduction and background information

The properties of food packages are nowadays very good, including the safety aspects. However, a novel problem has arisen: how to open the package easily. This is a challenge not only to consumers with reduced hand function but also for many others. It is common for all of us to face every now and then difficulties in opening packages of consumer goods. Especially adult consumers with reduced hand function, such as rheumatic or elderly people, or children are familiar with this issue. But what are the most critical factors for consumers in opening the packages?

In this study we concentrated on evaluating the easiness to open food packages, which are most frequently used among the consumer goods. It appeared that a very wide variety of different types of opening mechanisms of food packages exist. Different movements and capabilities are required from consumers to fend from the opening process and handle successfully the packages.

How to evaluate the easiness to open packages? The principle of selected mechanical tests, sensory evaluation and consumer studies will be presented aiming to describe possible test methods to determine the easiness to open.

Originally, the main aim of the present project was to provide scientific background information to create an international standard to evaluate the easiness to open packages. However, the CEN standardisation work started already before the results of the current project were available. A short history of the progress of the standardisation is presented.

1.1 Demands of consumers

1.1.1 Introduction

Easy opening of consumer packaging is becoming a major issue and a more frequently expressed demand among consumers. In a recent survey conducted in October 2005 by TEMO in Sweden for the Swedish Rheumatism Association, two out of three Swedish consumers are prepared to pay more for better and easier open packages (1). All consumers appreciate easy-to-use packaging, but the problem is especially apparent when looking at people with a disability or elderly people, which is a category of the society that is increasing rapidly. Ageing brings with it many issues; not least the loss of strength and dexterity, which often is the cause why consumers have difficulties in opening packages. The latest data from Eurostat reports that 14.5 % (1997) of the population in 15 European member states are disabled and 15.8 % (1997) are aged 65 years or older in the 15 European member states, representing 77 million persons or 30 % of the European population (1997). In order to design effective packaging, it is important to understand the ability of disabled and elderly consumers. Consumer packaging should be able to be opened by most consumers, regardless of age or physical ability, and by setting appropriate design limits to cater for as wide a range of people as possible, we can assure that the package will be designed inclusively.
1.1.2 Screening of physical qualifications and capabilities of consumers

A number of different techniques and methods have been developed and used for measuring different aspects of physical qualifications and the capability of consumers. Most of these are based on measuring human strength data with the aid of different mechanical devices, which has limitations in its applicability to real life experience. Some of the most comprehensive studies have been commissioned by the UK Department of Trade and Industry, who have produced a series of publications containing ergonomic data for use in the design of consumer products. The three publications on children, adults and older adults (2,3,4) with human factor data on these three groups have been used to some extent for designing packages but revealed important “gaps” in the data available for direct use in package design. These difficulties initiated new studies and new strength data were collected to meet some of the needs, such as finger-push strength, pinch-pull strength, hand grip strength, wrist twisting strength and push and pull strength. (5). UK Department of Trade and Industry also initiated a study of the difficulties that disabled people experience in everyday life, and identified a number of products and one of these was packaging (6). Besides identifying the products disabled people had most difficulty with, the study also identified strategies disabled people needed to use when coping with consumer products. These strategies generally involved motor factors such as reaching, gripping and manipulation, but also included lifting and transporting. Products requiring 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 very difficult. Data on the strength capabilities of disabled people over a number of hand functions can be found in the report “Specific anthropometric and strength data for people with dexterity disability (7). The results demonstrate considerable differences between the strength capabilities of disabled people and non-disabled people. In all of the tests the strength capabilities of non-disabled people were between two and three times that of disabled people, which poses a considerable challenge to designers and manufacturers of consumer packaging if they are to produce products that disabled people will be able to use with the same degree of ease and convenience as that expected by non-disabled people. For example exerting twisting forces as when unscrewing the lids of screw top jars will need to be limited to a torque as little as 0.25 Nm for a sizeable proportion of those with dexterity disabilities are to be accommodated. Similarly opening packaging that involves pulling on small tabs will need to be restricted to pull force levels of approximately 5 N if again, a sizeable majority of disabled people are to be catered for. However many of the tests that have been used to measure the data do not accurately represent the actions used to open packaging, and the human strength is very dependent on the action being performed. Other aspects are those related to coefficient of friction between skin and jar material. The Researchers at University of Sheffield has developed a torque-measuring device that aim to measure the actual torque that people can apply, and they found that both age and physical condition of the subject influence the amount of force that can be generated. (8). As age increases past 60 years of old, strength begins to reduce rapidly, and even seemingly small changes in materials or geometry can have a large impact on the forces a consumer is able to generate. Particularly the strength data for consumers over 60 is in this study much lower than in the data from UK Department of Trade and Industry. Other methods for measuring the physical qualifications have been developed primarily for therapeutic use for people suffering from arthritis, and example of these are; Grip Ability Test (GAT), Electronic Grip Force Meter (Grippit®) (9, 10). These test methods were used in the thesis by Ulla Nordenskiöld evaluating the difficulties in daily life of women suffering from arthritis, ADL (Activities of Daily Living). Apart from a reduced grip force the patients with arthritis often have pain, which to a large extent affect their performance of daily activities. (11).

The reduced capability can be caused by impairment or activity limitations often summarized under the umbrella term disability or it can be aspects of health and health-related states (diseases, disorders, injuries, traumas etc) summarized under the umbrella term functioning.
persons functioning and disability is interacting with contextual factors; both personal and environmental factors. In order to understand different levels of function and how to distinguish pathology, impairment, disability and handicap the international concept and classification developed by the World Health Organisation, WHO, first published in 1980 and revised 2001 is the most comprehensive and the most widely used. (12, 13). When the capability of handling packages is concerned, from a consumer point of view, the following factors could influence their capability:

- reduced hand strength
- left or right-handed
- reduced sensibility/sensitivity
- reduced dexterity
- reduced power grip
- co-ordination difficulties
- shaking
- pain
- medical treatment
- visual capability
- cognition
- personality

1.1.3 Conclusions

The problem of difficult-to-open packaging is expressed by many consumers, but is especially apparent for elderly people and disabled people. Reduced dexterity and strength mean packaging that a younger, fitter or healthier person might have no trouble opening become impossible to gain access to. Age has a profound influence and for people above 60 years of old there is a remarkable decrease in human strength data, and there are also big differences between male and female. The data from Yoxall et al 2006 reveal that half the female population aged 75 years of old will be unable to open 50% of the jars they buy, and as age increases further the problem worsens and more and more women will be unable to open a larger percentage of jars. The forces that human can apply are dependent on many factors, related both to the consumer and packaging itself, which suggests that specific testing is required to determine the forces that a consumer will be able to apply to a specific package. When the strength of the weakest consumer in the target group has been established, design limits based on the strength of the weakest user can be set.

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1.2 Selection of experimental settings

1.2.1 Target group

The criteria of selecting the test persons are crucial. As in any test, the test can only be as good as the test material, and the whole test setup depends on this step. One can choose a very narrow and well defined target group in order to be sure of reproduction of the scenario, but in this case all aspects of importance may not be well described. The balance between these two conditions should be a matter of considerations.

The number of selected test persons is another issue of importance. Thus, it may depend of statistical unravelling: level of significance for acceptance and number of test persons.

1.2.2 Packages

Selection of packages to the experiments to be conducted should be based on (a) the physical restrictions of the selected target group in opening packages and (b) the requirements set for the packages to be easy to open.

(a) Physical restrictions of the target group in opening packages

- **Forbidden physical paths**
  - Key pinch grip (~catch with fingertips)
  - Use of power
  - Twisting or rotation of wrist

- **Avoided physical paths**
  - Pulling by using power
  - Lifting by using power
  - Pushing by using power

- **Allowed physical paths**
  - Pulling with straight wrist
  - Lifting with straight wrist
  - Pushing with straight wrist
  - Pressing

(b) Requirements for the easy-to-open packages

- **Size & shape**
  - Big enough to catch but still fits in hand; suitable for different-sized hands
  - Large contact surface against the hand
  - Ergonomic in hand
  - Not too heavy
  - Shape guides to use the package
  - Place to catch the package: impact of holes, hand holes or sticks

- **Material**
  - Strong enough
  - Possible to catch
  - Coarse surface

- **Opening mechanism**
  - Easy to catch
- Big enough
- Use of power minimised
- As straight as possible
- No demand for precision
- No demand for coordination
- Arrows to guide the opening, simple

Different types of packages from Sweden, Denmark and Finland representing different opening systems were screened. They were representing packages requiring various abilities of movement, such as screwing/rotation, lifting, pushing and pulling/tearing, to be opened. Packages are listed below based on their opening mechanism.

Below are listed some examples of packages having different types of opening mechanisms

- Jam in wide glass jar with metal top/ Juice bottle/ Pharmaceutical can with screw cap/
  Juice in tetra brik with slim cap/ juice in tetra brik with stream cap
- Ring-pull tins (e.g. pineapple, pea soup)/ Soft drink or beer can (metal)
- Coffee in vacuum package
- Sliced sausage/ ham (or cold cuts) in vacuum package (plastic laminate in vacuum)
- Candies/ chips/ spices in plastic laminate bag
- Biscuits/ cookies in tight laminate foil or with a tight cellophane film on
- Yoghurt/ sour whole milk/ crème fraiche in plastic pot with aluminium lid/ paper laminate lid
- Margarine spread pack with lid and paper-aluminium laminate
- Margarine in paper-aluminium wrap
- Sliced sausage (or cold cuts) in hard plastic package with removable plastic lid
- Juice in tetra brik with perforation/ with pull tab/ with recap
- Carton of milk
- Bread in plastic bag with closure
- White wheat flour (2 kg)/ sugar in paper bag
- Frozen food etc. with tear strip/ Oatmeal in paper bag and carton box (double package)
- Bread in paper bag
- Egg package
The number of sample packages of the study was restricted for practical reasons to eight. These selected packages are presented in chapter 3.1.

### 1.2.3 Test methods

Traditionally mechanical tests have been used in industry while evaluating the easiness to open designed packages. However, sensory and/or consumer studies may be suitable options for that, too.

#### 1.2.3.1 Mechanical tests

A mechanical test can provide quantitative and objective results of different test set-ups. Commonly a mechanical test measures the force used for a specified test operation. The advance is clear due to very accurate replication of test conditions and possibility of easy change of one or more factors. The test may often follow a standard procedure for which a measurement interval of acceptance has been defined. Thus, the method is in general easier to implement and run than other test forms. The disadvantage consists in difficulties in constructing a reliable test set-up, which comply with the purpose of the measurement. If the test set-up does not fit the purpose the result is more or less useless or should be supported by more informative test forms, and the method does not include the human perception.

#### 1.2.3.2 Sensory assessment

A well trained sensory panel works like an instrument making an objective perception on a product. In this project it was examined, if it would be possible to replace instrumental or consumer studies by sensory evaluation in determining the easiness to open packages. The most effective method for this is descriptive profiling, where a trained, analytical panel evaluates the intensities of the pre-
determined sensory attributes from the products. The weakness of sensory profiling is the requirement of the trained panel, but after training once the panel will be available continuously. The benefit as compared to instrumental methods is that by descriptive profiling it is possible to get an overall view from the opening ability of the package as a whole, and not just regarding to one attribute at time. Sensory evaluation is a laborious method but still considerably less laborious than consumer tests.

1.2.3.3 Consumer studies
Consumer studies with the target group and the test packages of interest are often the ultimate test method, often used to validate instrumental or mechanical tests as well as analytical sensory tests. The consumer testing, as all other types of tests, requires special controls and the use of standard practices. One of the critical factors in all consumer studies is the definitions of the target group and how the inclusion and exclusion criterias are set and followed in the recruitment of the respondents that should represent the target consumer. Others are the set up of the consumer testing irrespective if the data collection is done by questioning or observation. The test design, the location, the sample presentation together with a number of psychological factors are all important for the reliability and validity of the consumer testing method.

1.3 Standardisation

The European standardisation organisation, CEN, started in March 2007 a new work item based on a Swedish proposal. Until now four meetings have been organised. Following work group was organised in TC261 packaging:

CEN/TC 261/WG 2 "Packaging – Ease of opening".  
CEN/TC 261/WG 2 Nr. 32 draft for WG meeting in Brusselles 7 May.2008

Scope

The Standard will specify the following, for all adult consumers:

- criteria for ease of opening of packages
- a method for evaluating the ease of opening of consumer packages

The purpose of this Standard is to specify a test method to evaluate the ease of opening of consumer packages in order to improve easy and safe access to the contents.

Opening tools not integrated in the package are excluded from the scope of this standard.

The working group has a Swedish Chairman and secretariat and all other participate as experts and not as official national representatives. TC261/WG2 shall write a proposal for a standard but can not decide to implement such a standard. After the TC261/WG2 has reached a consensus agreement the proposal will be send to TC261. According present CEN time rules TC261/WG2 should reach agreement before June 27th 2008.
TC261 can decide to send the proposal to a public hearing in Europe. First the standard will be translated to the official CEN languages: English, French and German. Next the proposal will have an official number prENxxxxx (the proposal will first a pre European Norm xxxxx but the work has not reached that level yet in summer 2008). The proposal will then through the national standardisation organisations send to a public hearing for 5 months. All stakeholders can send in comments through the national organisations. The national standardisation committees will collect comments and send the first votes for the standard.

Next the TC261/WG2 shall get all comments collected by TC 261 from national committees. WG 2 shall consider all comments and write the final standard. The final proposal will then be send to a voting procedure. The national committees shall vote once more – and can not vote more negative than last time. If a proposal can collect majority after EU rules the prEN will be a final standard as ENxxxxx (the number is not given yet).

Several proposals have been made over the last 1½ year. However, TC261/WG2 has not reached a final proposal yet, and has asked for half a year extension for extra testing of the standard proposal in UK and possible other countries. A number of elements in the standard are clarified but up to the last minutes it is possible to change. After the meeting in Baden near Vienna 19 February 2008 and 7 may in Brussels following elements in the proposal have reached consensus status:

<table>
<thead>
<tr>
<th>Age range (years)</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-74</td>
<td>8 or 7</td>
<td>17 or 18</td>
<td>25</td>
</tr>
<tr>
<td>75-79</td>
<td>7 or 8</td>
<td>18 or 17</td>
<td>25</td>
</tr>
<tr>
<td>80-</td>
<td>15</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The test will be performed on a test panel of 100 test persons. These persons must not have participated in similar test within one month. Denmark has proposed a sequential testing procedure with 20 test persons. WG2 are positive to the Danish proposal and will evaluate the proposal.

The test will be done as follows:

- The test person has a package in 5 minutes without any other instructions that printed on the package. The test is failed if 90% cannot open it in 5 minutes.
- Then the test person has a new package and has 1 minute to open. The test is failed if 90% cannot open it in 1 minute or a 10% of testers refuse to open it again.
- The package is accepted if 90% or more are satisfied with the opening.
- The Danish proposal is that if 100% of a smaller group (10-30 test persons) with the same age and sex distribution can open then the package shall be accepted (the Governor shall still discuss this with the statistical experts).
2 Objectives

One of the main aims of the project is to collect scientific background information for the European standardisation work. In addition, the purpose is to give guidance for companies to improve the ease of opening of consumer packages in order to increase easy and safe accessibility of the content. The scope for the standardisation work in CEN (the European Committee for Standardization) is to create criteria and test method for evaluating the easiness to open of consumer packages.

The project is focused
- to screen physical qualifications and capabilities of consumers to open packages easily
- to search critical aspects in opening different types of food packages
- to identify the most relevant method(s), which has (have) the necessary qualifications for providing the basis for the final test method
- to inform, interest and involve Nordic companies in product development work
- to create the scientific basis for the development of the test method for the standard

3 Experimental studies

Eight commercial food packages deviating in their opening mechanism were selected for model packages of the present study. The easiness to open these commonly selected packages was tested by using several mechanical and sensory experiments, and three consumer studies were carried out in Sweden, Denmark and Finland. The outline scheme of the Easyopenpack project is presented below. The actions, responsibilities and time schedule of the project are presented more detailed in Table 1.
### Table 1. Actions, responsibilities and time schedule of the project.

<table>
<thead>
<tr>
<th>Action</th>
<th>Responsible partner</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of the data from the previous tests conducted in 2004</td>
<td>SIK</td>
<td>Oct 2007</td>
</tr>
<tr>
<td>o Sensory tests at SIK and consumer tests (n=100) at Spenshult</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Five packages, only one common with the 8 packages used now</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply of packages to all new tests</td>
<td>DTI</td>
<td>Aug 2007</td>
</tr>
<tr>
<td>o Packages (8) suggested by VTT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus group tests with the eight new packages</td>
<td>Spenshult Reumatikersjukhus</td>
<td>Oct 2007</td>
</tr>
<tr>
<td>o To compare the results obtained in 2004 and 2007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer test on the eight packages</td>
<td>DTI, Finnish Rheumatism Association (VTT)</td>
<td>Oct 2007</td>
</tr>
<tr>
<td>o Test persons (n=100 'seniors') selected as described in 'adult testing' in ISO 8317</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Comparison of the VTT and DTI results (and earlier results of SIK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory profiling by a trained panel on the eight packages</td>
<td>VTT</td>
<td>Oct 2007</td>
</tr>
<tr>
<td>o Comparison to the earlier sensory results of SIK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical test on the eight packages</td>
<td>DTI, Tetra Pak, Stora Enso</td>
<td>Oct 2007</td>
</tr>
<tr>
<td>Standardisation work</td>
<td>DTI, Pakkausteknologia PTR</td>
<td>Continuously</td>
</tr>
<tr>
<td>Analysis of all data and the final report</td>
<td>Steering group (VTT, SIK, DTI) and all other partners</td>
<td>June 2008</td>
</tr>
</tbody>
</table>

## 3.1 General

### 3.1.1 Subjects

The target group of consumers considered for the “easy opening” is consumers with a light to moderate limited hand function as defined in the ICF (WHO standardisation of difficulties. In the qualitative as well as the quantitative consumer tests performed in the Easy open project were consumers aged between 50 to 90 years of old who all declared that they had problems in opening and handling packages. An overweight of females was recruited and the target was to have 1/3 men and 2/3 females. The individual’s limitation of hand function was measured both by self-administered questionnaires and with practical tests and/or hand strength measurements. In the quantitative consumer test performed in 2004-2005 rheumatic patients were recruited who had at least 50% reduced hand functionality, documented by practical tests and hand strength measurements.
3.1.2 Packages

Food packages representing various types of opening mechanisms were selected for the study. The selection of packages was commonly agreed by the participants of the EASYOPENPACK project. Danish Technological Institute, Denmark collected and provided the packages to all project participants. The eight packages selected for the experimental studies were (Fig. 1)

**K – MEDICINE (MITT VAL): Pharmaceutical pot with screw cap container with a pull-ring**
The packaging is a 110 ml plastic screw cap container for vitamin tablets. The closure has a 51.3 mm diameter cap. Inside is placed a pull-ring.

**L – HAM: Sliced ham in hard plastic package with removable plastic**
Vacuum packed ham in thermoformed plastic tray including a slip for easy opening. The slip is 13mm long. The opening procedure is to catch the slips at the corner of the packages and separate the sturdy top foil and the tray.

**M – MILK: Carton of milk of paper board**
The gable top, paper board container contains 1 litre of milk. The opening procedure is by separation of the wings at the marked end of the gable top. The wings are push backward followed by forward push and pull forming the spout.

**R – BISC ZIPPER (BISC TAPINI): Biscuits in paper box with tear strip and with a bag of metallic foil inside**
The paper box with tear strip includes a bag of metallic foil containing the product. The opening procedure for the paper box is to catch the tear strip and pull. The metallic foil bag inside the paper box is sealed by two sets of wings glued together. The opening procedure is to separate the wings. When the package is broken peeling of the seal is possible.

**S – TIN: Ring-pull tin of aluminium**
Cylinders can, “mackerel in tomato” with pull-ring. The can has a diameter of 7.5cm. The opening procedure is by bending the pull-ring 90-180° before pulling the opposite direction. The angle of force is adjusted according to the position of the lid during the opening process.

**T – COFFEE: Vacuum-packed coffee block in metallic foil**
Vacuum packed coffee in block is packed in metallic foil. The top is fasted by a slip of tape which can be used for re-closing. The packaging is sealed by two sets of wings glued together. The opening procedure is to separate the wings after removal of the tape. When the package is broken it takes in air making peeling of the seal possible.

**V – CANDIES: Candies in plastic laminate bag**
The plastic bag with candy is produced in a vertical form-fill-seal machine. The top seal tear apart by pulling in each direction. The top seal breaks easily with use of the pre-cut for easy opening.

**X – BISC TEAR STRIP (BISC DIGESTIVE): Biscuits in tight roll of metallic foil with an opening strip**
The biscuits are packed in a roll of metallic foil with a slip at the top of the packaging for easy opening. The opening procedure is to catch the slip by thumb and first finger and the packaging is broken by pulling the strip.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K</strong></td>
<td><strong>L</strong></td>
<td><strong>M</strong></td>
</tr>
<tr>
<td>MEDICINE Pharmaceutical pot with screw cap container with a pull-ring</td>
<td>HAM Sliced ham in hard plastic package with removable plastic</td>
<td></td>
</tr>
<tr>
<td><strong>N</strong></td>
<td></td>
<td><strong>O</strong></td>
</tr>
<tr>
<td>MILK Carton of milk of paper board</td>
<td>BISC ZIPPER Biscuits in paper box with tear strip with a bag of metallic foil inside</td>
<td></td>
</tr>
<tr>
<td><strong>P</strong></td>
<td><strong>Q</strong></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>TIN Ring-pull tin of aluminium</td>
<td>COFFEE Vacuum-packed coffee block in metallic foil</td>
<td></td>
</tr>
<tr>
<td><strong>S</strong></td>
<td></td>
<td><strong>T</strong></td>
</tr>
<tr>
<td>CANDIES Candies in plastic laminate bag</td>
<td>BISC TEAR STRIP Biscuits in tight roll of metallic foil with an opening strip</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1. The eight selected package samples for the experimental studies.*
3.2 Mechanical tests

Helle Antvorskov/ DTI  
Experimental studies by DTI, Stora Enso Oyj and Tetra Pak Packaging Solutions AB

3.2.1 Abstract

The mechanical testing was divided among the partners Danish Technological Institute, Stora Enso and Tetra Pak. For most of the measurements done, comparable results were obtained irrespective of the places of test. However, three types of packaging measurement do not correlate. These packages are M Milk, forming the spout, the V Candies and the K Medicine, opening the cap. Differences in the methodology can explain the obtained differences in the opening force of the V Candies and the K Medicine, but not completely for the M-Milk.

3.2.2 Materials and methods

The sample packages were the eight commonly selected food packages presented in chapter 3.1.

The mechanical testing was divided among the partners Danish Technological Institute, Stora Enso and Tetra Pak (Appendix 1). Danish Technological Institute provided test results of all eight samples Stora Enso tested all samples except K Medicine and Tetra Pak provided test results for K Medicine.

**Danish Technological Institute**

The equipment used is an Instron 5569 torque meter. Test type is Tensile and the crosshead speed is 100 mm/min with full scale load range of 5.0000 kN.

The samples where prepared by emptying all content and cutting out the opening mechanism of each packaging sample. To imitate the displacement of force during the opening procedure strings and clams were use for most of the measurements. For the milk container, metallic can and paper box with tearstrip it was necessary to open the packages in two operations. The detailed procedure for each packaging is shown in Appendix 1, DTI.

Bottle tester, TORNADO (JKM systems, DK) was used for measuring the torque during cap opening of K Medicine. The package was fastened to the measurement cell. The cap is loosened by manual power and the maximum torque required is measured.

**Stora Enso**

The equipment used in the tests is a tensile tester model: Zwick ZN 010. The setting for the equipment is based on standard test procedures and programmes used on a daily basis. Machine speed at test is 500 mm/min.

For several of the packages the opening procedure is a moving/gliding process with continuous displacement of the force, the angle of the pulling is important for the force applied. Special equipment where used for this, i.e. rail with a low friction sleigh. For the M Milk and S Tin it was necessary to open the packages in two operations. The detailed procedure for each packaging is shown in Appendix 1, Stora Enso.

**Tetra Pak**

An Instron torque meter is used for measuring the torque during cap opening. The package K Medicine is placed in a fixture attached to a plate that registers the torque while a rotating fixture
opens the cap. The cap is opened with 4320 degrees/min. The detailed procedure for each packaging is shown in Appendix 1, Tetra Pak.

A Zwick machine is used for measuring the force when opening the pull-ring membrane. A fixture is holding the package at 20 degrees and the pull-ring is fasted in a clamp attached to a moving crosshead. The crosshead moves upward at a speed of 100 mm/min and the force is measured by a load cell in the crosshead. The measurement ends when the pull-ring membrane comes loose completely. The detailed procedure for each packaging is shown in Appendix 1.

### 3.2.3 Results

The results for the mechanical testing are shown in Tables 1-4 in Appendix 1. All data from the mechanical tests is summarised in Table 2.

#### Table 2. Results of Danish Technological Institute, Stora Enso and Tetra Pak performed on the eight packages for test. Number of replicates is shown in brackets after the results. Please notice that torque is in N*m.

<table>
<thead>
<tr>
<th>Average Force at peak Newton</th>
<th>DTI</th>
<th>Stora Enso</th>
<th>Tetra Pak</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Tin (turning ring)</td>
<td>11.6 (10)</td>
<td>11.2 (5)</td>
<td>-</td>
</tr>
<tr>
<td>S Tin (pulling ring)</td>
<td>49.3 (10)</td>
<td>43.7 (7)</td>
<td>-</td>
</tr>
<tr>
<td>R Bisc-Tapini (tear strip of box)</td>
<td>5.1 (10)</td>
<td>4.7 (5)</td>
<td>-</td>
</tr>
<tr>
<td>R Bisc-Tapini (foil bag)</td>
<td>2.5 (10)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>L Ham</td>
<td>8.4 (10)</td>
<td>9.7 (7)</td>
<td>-</td>
</tr>
<tr>
<td>X Bisc-Digestive</td>
<td>3.4 (10)</td>
<td>3.7 (6)</td>
<td>-</td>
</tr>
<tr>
<td>M Milk (separate wings)</td>
<td>23.9 (10)</td>
<td>24.4 (6)</td>
<td>-</td>
</tr>
<tr>
<td>M Milk (forming spout)</td>
<td>20.3 (10)</td>
<td>9.1 (8)</td>
<td>-</td>
</tr>
<tr>
<td>T Coffee</td>
<td>44.9 (10)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>V Candies</td>
<td>9.3 (10)</td>
<td>2.8 (7)</td>
<td>-</td>
</tr>
<tr>
<td>K Mitt-Val (cap), torque in N*m</td>
<td>0.89 (10)</td>
<td>-</td>
<td>0.47 (17)</td>
</tr>
<tr>
<td>K Mitt-Val (pull-ring)</td>
<td>62.8 (10)</td>
<td>-</td>
<td>56.1 (17)</td>
</tr>
</tbody>
</table>

#### 3.2.4 Discussion and conclusions

For most of the measurements done, comparable results were obtained irrespective of the places of test. However, three types of packaging measurement do not correlate. These packages are milk container, forming the spout, the candy package and the K Medicine, opening the cap. Differences in the methodology can explain the obtained differences in the opening force of the candy package and the K Medicine, but not completely for the milk container.

**M Milk**

The average results obtained for the M Milk container, forming the spout was at Stora Enso 9.1N while the Danish Technological Institute measured 20.3N. Stora Enso ran the test at 500 mm/min while the Danish Technological Institute chose a speed of 100 mm/min. Commonly a larger speed of test will lead to a higher peak, thus, this can not be the explanation. The sample preparation is quite similar; Stora Enso has placed a hook at the beginning of the spout while the Danish Technological Institute has fastened the pulling string 1cm below the opening of the sprout (See Figure 2). A possible explanation for the different results may be that the hook has made a hole in the seal before running the test resulting in a lower required opening force. This theory is supported by comparing the graphic illustration of the path run of the stain; see Appendix 1 both for DTI and Stora Enso. The difference in the results in step 2 between Stora Enso and DTI for the milk container might be due to the different treatment of the packages in the first step: at Stora Enso the wings were maybe bended more than at DTI.
V Candies
The average results obtained for the V Candies was at Stora Enso 2.8N while the Danish Technological Institute measured 9.3N (see Figure 3). The difference in result is due to the method used: Stora Enso has measured the force required with use of the pre-cut of the top seal while Danish Technological Institute has used the “trouser method” at a random point of the top seal.

K Medicine
The average results obtained at Tetra Pak for the K Medicine, opening of the cap was 0.47 N*m while the Danish Technological Institute measured 0.89 N*m. The difference in result is due to the method used: Tetra Pak has measured the force required excluding friction force while Danish Technological Institute has used hand power, for which friction force can not be excluded (see Figure 4). The friction force is known to be important because the easiness of opening is dependent on the materials grip ability. However, the result of the measurement is not as reproducible because it is influenced by the person performing the test.

When using finger forces, the fingers will press the lid and the container oval and increase friction. For that reason fixture, like used at Tetra Pak, will always be able to open with less torque. These finger forces are needed to create friction between the fingers and the lid (see Figure 5).
3.3 Analytical sensory study

Annika Åström/ SIK and Raija-Liisa Heiniö/ VTT
Experimental studies by SIK (interviews) and VTT (sensory profiling)

The aim of the analytical sensory assessment was to study, if it is possible to use a sensory method for measuring the easiness to open packages. The study consisted of two phases:

- Attribute generation by a consumer panel aiming to measure the easiness to open packages by a sensory panel
- Evaluation of the easiness to open packages by an analytical sensory panel by using descriptive profiling with the vocabulary created above

The key attributes regarding the opening of packages was found out by using a laddering technique. The data was collected in interviews by SIK according to the instructions provided by VTT. The data was processed by a sorting method and the sensory profiling was conducted at VTT.

3.3.1 Abstract

Analytical sensory study was performed in two steps: 1 – Generation of novel attributes for testing the easiness to open packages, and 2 – descriptive profiling of the eight common food packages by using the elicited attributes used by a trained sensory panel. The chosen attributes were visibility, clarity, gripping, tightness and breakage of the opening mechanism, strength and need to use both hands in opening the package, rigidity and slipperiness of the packaging material, gripping and breakage of the package while opening, and staying of the product inside the package after opening.

The coffee package T Coffee followed by the candy bag V Candies (due to the poor visibility and clarity of the opening mechanism) were most difficult to open, whereas the milk container M Milk and the tin S Tin were assessed as rather easy to open. Some of the attributes, such as the visibility and clarity of the opening mechanism, or the tightness and need of strength, seemed to measure quite the same characteristics.

3.3.2 Qualitative study for attribute elicitation

3.3.2.1 Method

To generate reliable and relevant attributes for the analytical panel a qualitative laddering technique was used with elderly consumers having difficulties with opening packages. The criteria in selecting the test persons were age (between 50-70 ± 5 years), gender (approximately 70% females and 30%...
males), and they declared to have difficulties in opening packages. In total 35 elderly consumers between 60 and 88 years of old participated in the study, See Figure below. The majority of the consumers were women, 79%, and the rest men 21%.

The consumers were recruited from a consumer database, and for those who corresponded to our inclusion criteria’s were booked in for interviews. The interviews were done by two technicians with experience of both qualitative and quantitative consumer studies during three commencing days in September 2007. The interviews started by presenting the randomly and coded pictures of the eight commonly selected packages.

The respondents were asked to group or sort the packages in those who the respondent believed was easy to open and those who were difficult to open. After the respondents had sorted the packages the interviewer randomly picked a picture from the easy to open group, and asked the respondents to explain why this package was easy to open and then they are asked from each package of the easy to open group, and all answers are listed. The same procedure was used with the packages from the difficult to open group. All attributes used by the consumers to explain why a package were believed to be easy or difficult to open, were listed and counted and used to decide which attributes that should be used by the analytical panel.

### 3.3.2.2 Results

The respondents were very homogeneous in which packages they believed were the most easy and most difficult to open. The package of the dry bread and biscuit coded R and X, were believed to be the easiest ones to open and the most difficult to open was the vacuum-packed coffee coded T. The other packages fell somewhere in between and some of the respondents believed they were difficult and others easy to open. The most frequently reason for believing the package R and X were easy to open was that the opening mechanism was clearly visible and that a low strength were believed to be used for opening, together with a stable package and easy to grip. The vacuum packed coffee was believed to be the most difficult one to open due to difficulties in gripping the opening mechanism and the tightness of the closing. Other aspects mentioned were attributes related to the believed breakage of the opening mechanism, the necessarily of using both hands in opening, stiffness of packaging material in opening mechanism, slipperiness of packaging material in opening mechanism, keeping the grip of the package and product stability in the package after opening.

### 3.3.2.3 Discussion and conclusions

From the interviews it was clear that a lot of the believed difficulties of opening different packages were related to the opening mechanism; how visible and clear is the opening mechanism, how easy is it to grip and how much strength is needed for opening. Other aspects were related to the need of
using both hands while opening, but also the slipperiness, stiffness and breakage of the packaging material.

### 3.3.3 Sensory study

#### 3.3.3.1 Method

Sensory attributes (describing the differences in the easiness to open the commonly selected eight packages) were generated by a laddering technique from the data of the consumer panel of SIK for the descriptive profiling. Descriptions of the respondents were divided into easy and difficult to open, and the number of each reason occurred was counted for each description and for each package (Appendix 2). The selected descriptive attributes were:

**Opening mechanism (OM)**
1 Visibility of the opening mechanism (Visibility OM)
2 Clarity of the opening mechanism (Clarity OM)
3 Keeping the grip from the opening mechanism (Keeping grip OM)
4 Tightness of the opening mechanism (Tightness OM)
5 Breakage of the opening mechanism (Breakage OM)
6 Strength needed to open the package (Strength need OM)
7 Need to use both hands in opening the package (Need both hands OM)

**Packaging material (PM)**
8 Rigidity of the packaging material (Rigidity PM)
9 Slipperiness of the packaging material (Slipperiness PM)

**Package (P)**
10 Keeping the grip from the package (Keeping grip P)
11 Breakage of the package while opening (Breakage P)
12 Product staying inside the package after opening (Product inside P)

A trained sensory multi-product panel of VTT (n = 10) determined the sensory profiles of easiness to open the sample packages in two replicate sessions by using the attributes elicited above (Lawless & Heymann, 1999). The assessors had no diagnosed hand dysfunction, which was checked by using the questionnaire on hand function (Appendix 4C of the chapter 3.4.2.3). A training session was organised before the assessments to the panellists for getting familiar with the attributes and the attribute intensities used. The attribute intensities were rated on continuous unstructured, graphical scales (0-10). The package samples were served to the assessors as coded in random order. Scores were recorded and collected using a computerized data system (Compusense Five, Version 4.8, CSA, Canada). Means of the sensory raw data were calculated. The significance of each descriptive attribute in discriminating between the samples was analyzed using analysis of variance (ANOVA) and Tukey's HSD (Honestly Significant Difference) test (significance of differences at p<0.05). Unscrambler (Ver. 9.7, Camo, Norway) was used for the PCA (principal component analysis).

By statistical multivariate techniques, such as PCA or PLS regression (partial least squares regression), it is possible to compress a big amount of data into one view. The percentages inform how much of the variation in the data is explained by the analysis. The plots generated by statistical multivariate analysis describe the relative distances of samples and different analyzing results (mechanical, sensory or consumer data) in the space. Thus, the x and y axes do not represent exact
values but are relative. The attributes and the samples located near each other in the plot are closely related with each other. The more far the attribute or the sample is from the origin, the bigger is its influence. Those attributes or samples located in the same quarter are linked positively with each other, whereas those located in opposite quarters are related negatively.

3.3.3.2 Results

The results of the sensory study are presented in Appendix 2 in detail. A PCA bi-plot for the packages analysed from the data of their sensory profiles shows the results in one view (Fig. 7). The coffee package was most difficult to open in respect to most of the assessed attributes: the opening mechanism was tight, required a lot of strength and both hands to be opened, the keeping grip both from the opening mechanism and from the package was worst, the packaging material was slippery, and both the opening mechanism and the package broke much during opening process. The candy bag had poorest visibility and clarity of the opening mechanism, and, together with the package of Digestive biscuits, it had least rigid packaging material and saved the worst the product in the package after opening. The milk container and the ring-pull tin were assessed as best in respect of five attributes: milk container had visible, clear and easily gripped opening mechanism, the package did not broke and the content stayed in the package while opened, whereas the tin had also visible and easily gripped opening mechanism, the packaging material was rigid and not slippery, and it was easy to get a good grip from the package.

3.3.3.3 Discussion

The visibility and clarity of the opening mechanism as well as the tightness and need of strength seem to measure quite the same characteristics, respectively. Also the keeping grip from the opening mechanism and from the package were somewhat related when these sample packages were evaluated, but this might not be true to all packages. Regarding to other chosen descriptive attributes, no clear relationships were noticed. This is a good sign, and means that the selected attributes measure different dimensions of opening the packages.

There might be slight differences between the importance of the attributes for the easiness to open packages. For example, if the opening mechanism is not visible or clear, it may cause the first hindrance for the opening. The opening procedure requiring too much strength is also crucial. And if the material is too slippery, it is difficult to get a good grip from the package.
Figure 7. PCA bi-plot for the packages analysed from the data of their sensory profiles. Two first PCs explained altogether 89% of the variation. (See chapter 3.3.3.1 for viewing instructions)

3.3.3.4 Reference

3.4 Consumer studies

Different types of consumer studies were done within this project and by several of the participating partners. Some of these were qualitative studies involving smaller group of consumers and generating qualitative data explaining and demonstrating how different consumers perceive the user friendliness of the tested packages. Others were quantitative studies involving larger group of consumers generating data where it is possible to statistically evaluate how easy or difficult the tested packages were perceived to be by the consumers. A qualitative laddering technique was used for elicitation of relevant attributes to be used by the analytical sensory panel. The laddering technique is based on randomly presenting pictures of the test packages and letting respondents sort them into one group which they believe is easy to open and one group which they believe is difficult. After the sorting the respondents are asked why each of the pictures of packages are easy to open, or difficult to open. The reasons mentioned why a package is believed to be easy to open or difficult to open are recorded and counted, and used for deciding which attributes to use with the analytical sensory panel. Qualitative focus group study was done in Sweden to evaluate how smaller group of consumers with severe disabilities perceived the user friendliness of the test packages. Normally 8 to 10 respondents are invited to the focus group and a focus group leader is explaining how the test will be done. Each respondent are first testing the packages in accordance with a questionnaire and afterwards the packages tested are discussed together and under the leadership of the focus group leader to further explain why the packages were perceived to be easy or difficult to handle. The quantitative studies were performed as in hall test, meaning that pre recruited consumers are invited to take part in a test of packages which are presented randomly and evaluated individually in accordance with a questionnaire. A test leader will inform and guide the respondents. The target group of the Easy Open project was elderly people aged 50 to 70 plus minus 5 years of old, who claimed that they had difficulties in opening packages. For the quantitative studies 100 consumers should participate in the tests, and the majority should be female, 70 % plus minus 5 %.

3.4.1 Focus groups

Maria Mattsson/ Spenshult Reumatikersjukhus

3.4.1.1 Abstract

The purpose with the test was to carry out one "approval test" of eight packages according to The Swedish Rheumatism Association (SRA) method as a part in the project “Scientific base for “Easy to open” packages.” If a package is easy to open for people with reduced hand function, it will be easy to open for everybody. SRA has together with Spenshult Rheumatism Hospital and Unicum-Design for all center, developed a method to test the accessibility of packages. When all the handling steps of a package reach the required level it gets the SRA approval. 22 participants with reduced hand function tested the different handling steps with the 8 packages in the project. Two out of eight packages got the approval.
3.4.1.2 Method

The test method idea is to focus on the handling problems of different products using participants with reduced hand function. The origin of the Swedish Rheumatic Association’s (SRA) test method is a design approach from a Japanese group (one participant was Toyota) worked with a method called Quality Function Deployment QFD (Andersson, 1991) in the 1970s. How the user feels in contact with the product should be used in the development processes (Jordan P., 2000) and it is a very important factor when designing products for humans. Bevan states that the objective of usability is the “quality of use” (Bevan, 1995). “Easy to use” often said to be the most important objective of “quality of use” and it is also the one of the main targets in the usability area. The SRA’s test method has its theoretical background in the Usability framework where usability as an attribute of the product or services, as in ISO 9241 (Smith, 1984) (Mayhew, 1992). “Usability: Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” (ISO 9241-11, 1998). A test starts with a demonstration of how the opening is thought (by the designer) to be done. This is done to avoid the Affordance (Norman, 1999) (Norman, 2002) factors. The affordance of opening is relative to the package design, users’ prior knowledge and experiences, and the context of use (Gibson, 1979). The test is therefore neutral to new innovative ways of opening packages.

The method for the test is close to the approach of experimental design (McBurney & White, 2004). The primary objective for methods based on experimental design, in industrial settings, is to extract the maximum amount of unbiased information regarding the factors affecting a production process from as few (costly) observations as possible. By following this kind of test design the test panel can be kept minimal. 20-25 participants test the packages in groups. The test panel must include participants with different kinds of reduced hand function: strength, agility, coordination, shaking and sense of feeling and difficulties with the following grips:

```
Pincett grip  Key grip  Chuck grip  Five fingers grip  Diagonal volargrip  Transversell volargrip
```

Questionnaires and measurements are used to document objectively the hand function. The packages handling steps are evaluated individually in practice and the test persons also answer a questionnaire. A scale 1-9 is used. 1=extremely difficult and 9=extremely easy. All of the handling steps are completed. Finally, the test is completed with a focus group discussion of the products. The mean values of each handling step are summarised in the results.

In 2004 a test with more than 100 participants with reduced hand function was performed. The results of this large group test are used as comparison for the other tests. One of the packages from this test group of 100 participants is used at every test for validation. All the test results are compared to see if they differ from the test group of 100 persons (Fig. 8).
3.4.1.3 Results

Following is the results from test in Spenshult 20070919 and at SRA in Stockholm 200709. The group included 22 participants in the age of 28-70+, 5 men and 17 women. The test persons had different forms of reduced hand function in various degrees (Fig. 9).

Test results from these 8 packages showed that the question “How does it feel to open the package/inner seal the first time?” had a decisive importance to the result. The mean value of that question is shown in the diagram below (Fig. 10) (all results in Appendix 3). It was Digestive and Candy who reached the required level (5) to get approval. The participants in this test received help in the steps they didn’t manage to complete and then went on to the next step.
Test and focus group result and proposal of improvement in each product:

**K Medicine:** 7(32%) of 22 did not manage to open the package at all. The inner seal was perceived as difficult and the lid could have a better design. A higher lid, a bigger groove and an angular container would make the handling steps easier. The inner seal was recommended to be omitted altogether if possible.

**L Ham:** 2(9%) of 22 did not manage to open the package at all. It was hard for the participants to get a grip of the flap and to find it. However, once you find it and get a grip it is easy to open. It can be closed again but the top is not firm. The opening can be marked better, bigger flap and a knob can make it easier to open. If the top had a tighter glue in the end it could be used to close again. An adhesive tape, to hold the top down when it is closed again would be necessary.

**M Milk:** 4 (18%) of 22 did not manage to open the package at all. This package is difficult to open the first time. The pouring is affected by the flap opening. It is hard to get a grip of this package. The participants used both their hands to lift and pour from it. The proposal was to put a cork on the package and change the design to make a better grip possible. A smaller package was another proposal.

**R BiscZipper:** 3(14%) of 22 did not manage to open the package at all. The cardboard was easy to open. The inner bag was hard to get grip of and that made it difficult to open. However, some of the participants thought it was easier than other bags in plastic. The bag could be improved by changing the design to making more grip possible and changing the surface to less slippery. It is always good to avoid double package so the cardboard package only can be a solution. On the cardboard the strip could be better marked and the flap to close again could be bigger.

**S Tin:** 5(23%) of 22 did not manage to open the package at all. This package is hard or impossible to open but some of the participants thought it is easier to open than other similar packages. Some can get the ring up but not pull off the top. The other steps of handling the package are easier.
Several test persons preferred ordinary tins cans when they can use the tools they already have. This kind of tin can with a ring can not be opened with tin can opener.

**T Coffee:** 18(82%) of 22 did not manage to open the package at all. This package was described as impossible to open without scissors. You can not close it again once you have cut it open. Big flaps to grip and glue that is less resistant could make the package easier to open. If the surface of the package would be less slippery it could be easier to grip.

**V Candies:** 1(5%) of 22 did not manage to open the package at all. Some improvements were proposed. The opening is not marked and when you open it the opening is so big that the contents risk falling out. The proposal was that the opening could be marked and the opening stopped earlier.

**X BiscTearStrip:** Every one of the test persons managed to open the package. The package was widely approved. A bigger strip that could be marked better would make it even better.

3.4.1.4 **Discussion**

Of the eight tested package only two got the approval according to the SRA method. These packages were the Digestive and Candy bag. Some of the other packages may get the approval provided they make small changes. It was noted that the Ham package opening differed from package to package. Some packages had a knob that made it easier to open and some did not. This most probably had an effect on the result for the ham package. If the packages would have been identical the ham package may have received the approval. That the milk packages have been frozen could have an effect on the handling steps and the test result. The strip on the Digestive was not correctly placed on every package. The participants then changed to an other package due to major problems in opening these malplaced strips. The coffee package is totally unacceptable for consumers with reduced hand function. It is almost impossible to open. Our view is that packages and products in the tests must be handled in the same way as they are sold in the stores. The construction likewise ought to be the same.

Who can identify difficulties with the openabilities’ best, is it an ordinary user, some experts or is it possibly persons with difficulties in their hand functioning? In the SRA’s method are persons with limited hand function used as test group. The thoughts is if individuals with limited hand function experience the package “easy to open” then individuals with lesser limitation in their hand function also experience it “easy to open”.

3.4.1.5 **References**

3.4.2 Quantitative tests

This chapter describes the procedures and results of three consumer tests evaluating the easiness to open of different types of food packages.

3.4.2.1 Quantitative test A – Cluster Analysis of rheumatic patients’ consumer data

Annika Åström/ SIK

Experimental studies by SIK

This study was performed already in 2004-2005 at SIK. The sample packages were different than in the current studies, except for the sample K – MEDICINE.

3.4.2.1.1 Abstract

In connection with a project performed for Reuma Development AB in 2004 by SIK the user friendliness of packages were evaluated both by a sensory analytical panel and by a rheumatic patient’s consumer panel. The data generated from these tests have been further analysed to evaluate if there are groups or segments within the 100 group of respondents taking part in the tests, and if these groups can be characterized in some way. We found that even within this quite homogenous group of respondents, representing people suffering from rheumatic diseases and with a very reduced hand strength that there where different groups or segments experiencing the user friendliness of the packages differently. While some respondents perceived one package to be very easy to open and handle, others found the same package to be extremely difficult to handle. Four clusters or groups were identified, and where one of these consisting of 27% of the respondents found all of the tested packages to be quite user friendly, while another group consisting of 23% found all packages very difficult to open and handle. The other two clusters representing 30% and 20% found some of the tested packages easy and others difficult. From the documented background data of the respondents it is evident that both gender and age as well as the diagnosed disease have an impact on the experienced user friendliness of the packages. The reduced hand strength also had some influence but since all respondents were on the lower end it was not that apparent, but would probably have when the comparison is made with people not suffering from rheumatic diseases.
3.4.2.1.2 Packages

The packages selected for evaluating the user friendliness were all jars or pots with a screwing lid, but selected to represent a wide variation in size, form, weight, balance and the type of movement necessary to open and handle the package. The package MittVal is used as a reference package in the SRA method (Unicum method), proposed for the CEN standard.

3.4.2.1.3 Sensory method

The sensory method used for evaluating the “user friendliness” of the different test packages was a modification of Quantitative Descriptive Analysis, QDA (ISO 13299). The attributes characterizing the perceived “user friendliness” as well as the procedure for evaluating these attributes was developed and defined by a sensory panel consisting of specially selected and trained assessors, under guidance of an experienced panel leader. For these trials the sensory panelists, apart from the criteria specified in ISO 8586 also was selected on the criteria of normal hand strength (measured with GAT and Grippit).

During a number of training sessions the assessors was exposed to different test packages and a set of attributes appropriate to describe the perceived “user friendliness” are generated through consensus. In addition, during the training period the panel decided on the sequence for evaluating each attribute. Late in the training sequence, a series of trial evaluations was performed to evaluate the individual assessors based on statistical analysis of their performance relative to that of the entire panel.

The actual product evaluations was performed by each assessor individually, seated in separated booths, and in three replicates. Standard sensory practices such as sample coding and sample presentation were used. A 10 cm graphic continuous line scale anchored 10 mm from each end with the terms slight and much, respectively was used for quantification of the perceived attributes. The attributes used by the analytical panel is defined and explained in Appendix 4A.

3.4.2.1.4 Consumer testing

The consumer test was done at Spenshult Hospital with 100 rheumatic patients, one respondent at a time, evaluating the user friendliness of the same five packages as the sensory analytical panel. All respondents had a diagnosed rheumatism disease and at least 50 % reduced hand strength (less than 100 N in one of the hands)\(^1\). The selected group represented well the statistical variation of different diagnoses of the rheumatic population in Sweden, had an even age distribution between 39 to 83 years of old and the majority were female, 86 %, and 14 % men. The tests were done as a hall test with about 10 respondents at a time and with a supervisor, informing the respondents what to do. The package samples were presented in randomized order and the questionnaire used is in Appendix 4A.

\(^1\) Normal hand strength is 200N, defined by ICT
3.4.2.1.5 Results

The analytical panel generated a number of attributes on the user friendliness of the packages related to the ease of gripping, necessary strength for opening and handling, easiness of taking out one dose of the content and emptying of the package, as well as a total judgment of the user friendliness taking all the other aspects into consideration. Significant differences in almost all attributes were found. The coffee jar with the square lid was considered to be the most user friendly together with the medical glass jar 60+, the medical plastic jar Medicine and the washing powder package less user friendly and the spice glass jar the least user friendly. Principal Component Analysis, PCA, demonstrate that there are two dimensions characterizing the user friendliness of these packages, one being the opening mechanism and one the movement and handling of the whole package (Fig. 11). The user friendliness of the coffee glass jar and the medicine glass jar 60+, is primarily related to the easiness of gripping the lid and the less strength needed for opening compared to the other packages. The perceived less user friendly medicine plastic jar is correlated to the higher strength necessary to open. For the spice glass jar it is primarily the difficulty in gripping and tearing apart the opening mechanism.

![PCA biplot for the packages analysed by the analytical sensory panel. Two first PCs explained altogether 75% of the variation (43%/32%).](image)

The consumer panel judgments of the same packages revealed more complexity. The coffee glass jar was in agreement with the analytical sensory panel considered to be the most user friendly, while the other packages were perceived to be fairly difficult or neither easy nor difficult if you only look at the mean values for the 100 group. For each of these packages you could find respondents who perceived them to be very user friendly and others who perceived them to be extremely difficult to open and handle. This indicates that there are groups of consumers who differ in their perception of how easy or difficult each package is. Cluster analysis revealed that there are four groups or segments of consumers within this 100 group of consumers, with the following characteristics;

- One cluster, consisting of 23%, for whom all packages are difficult, except maybe the coffee glass jar. These respondents are characterized by a group of only females with an average age of 63
years; Their mean value for the grip ability test (GAT) is 41 and the majority, 74% have the diagnose Rheumatoid Arthritis (RA), 13% Artros, 9% Psoa and 4% other diagnoses.

- One cluster, consisting of 27%, for whom all packages are quite easy to open and handle. These respondents are characterized by a group where 26% of them are men and the rest female with an average age of 60 year and a mean GAT value of 48, and where 48% have the diagnose RA, 7% Spondylatrit, 30% Artros, 7% Psoa, 4% Systemsjd and 4% other diagnoses.

- One cluster consisting of 30%, for whom the coffee glass jar, the medicine glass jar 60+, and the spice glass jar is easy to open and handle but not the medicine plastic jar or the washing powder jar. These group of respondents are characterized by a group where 17% of them are men and the rest female with an average age of 63 year and a mean GAT value of 46, and where 73% have the diagnose RA, 10% Spondylatrit, 10% Artros and 7% Psoa.

- One cluster consisting of 20%, for whom the coffee glass jar and the medicine glass jar 60+ is easy to open and handle but non of the other packages. These group of respondents are characterized by a group where 90% is female and 10% men with an average age of 62 year and a mean GAT value of 41, and where 75% have the diagnose RA, 15% Artros, 5% Psoa and 5% Systemsjd.

Relating statistically the results of the analytical sensory panel the cluster consumer data, illustrated in Fig. 12, shows that although the clusters are separated, they are all located on the right side of the PLS regression plot, and seem to measure all the same dimensions of the “user friendliness” of the different packages.

Figure 12. PLS regression plot of the analytical sensory data and the consumer cluster data for the five tested jars or pots with screwing lids. The two first principle components explain altogether 62% of the variation (40%/22%).
3.4.2.1.6 Discussion and conclusion

Although a number of different aspects in opening and handling of packages were evaluated by both the analytical sensory panel and the consumer panel it seems as if primarily two aspects were the critical and differentiating ones, namely the opening mechanism and the movement necessary for opening and handling the package. The consumer group was selected to represent the Swedish population of people suffering from rheumatologic diseases and who had a documented impaired strength to open packages. The consumers should demonstrate to have at least a 50 % reduced hand strength measured with two clinically validated methods the so called Grip Ability Test, GAT, and Grippit test. (See References under chapter 1.1. Demands of Consumer). The results clearly showed that, in this comparably homogenous group of respondents, large differences were documented in their perceived easiness of opening and handling of the tested packages. One group of consumers perceived all of the packages fairly easy to open and handle, and among these there where more men than in the other groups, the average age of the group were lower, 60 year, and the GAT value higher and the number of respondents with the diagnose RA was lower. The group who perceived all of the tested packages to be difficult to open and handle were those where all were female with a higher average age, 63 year, low mean GAT value and a high percentage of RA patients. It has been demonstrated elsewhere that gender and age are critical for strength and dexterity, and that patients suffering from RA often experience pain which will influence the easiness of opening and handling of packages. These tests have shown that rheumatic patients are not a homogenous group when the open ability or ease of handling packages are concerned, and it might be better to use other groups e.g. elderly female.

3.4.2.2 Quantitative test B

Helle Antvorskov/ DTI

Experimental studies by DTI

3.4.2.2.1 Abstract

61 test persons in total, 19 males and 42 females in age between 50 and 92 years old, are participants in the test. 50 persons of those are experience trouble with opening packages. The consumer test is performed without any opening instruction before the test. Each person is provided 5 min. to try to open the package. If the person is not able to open the packages within the 5 min, instruction is given and the person may try aging provided only 1 min. If the person is successful within these time limits, the package gets a pass. The test person is asked to reply to a questionnaire regarding easiness of handling the packages. The judgment of easiness returns a score from 1 to 5, with 1 as easy and 5 as difficult. If any of the steps are too difficult for the test person within 1 minute the supervisor is allowed to help in order to reach the next step. The strength measurements of all test persons included grip strength, pinch strength: 1) Tip pinch, 2) Key pinch, 3) Palmar pinch (three fingers) and wrist strength.

The obtained results showed that gender, age, strengths is important parameters when opening packages is evaluated. The outcome of the questionnaire correlates very well with the time keeping, showing that experienced trouble of opening the first time is related to the time spend for opening the package. The same correlation is not found between strength needed and experienced easy opening, which makes the mechanical measurements less informative in question of easy opening evaluations. If score 3 is used as a pass code of the questionnaire (of a scale 1-5), the only packages which not gets a pass are Candies and Coffee, and all others did.
3.4.2.2.2 Method

Strata
- **10 persons as reference group**: Persons shall consist of 2/3 females and 1/3 males. Persons without difficulties in opening of packages are selected.
- **50-90 persons as test group**: Persons shall answer “Yes” to the following question: “Do you often have difficulties opening packages?” The groups shall consist of 2/3 females and 1/3 males. All persons in age between 50-90 years and as uniformed distributed as possible.
- 1/3 of the test persons in the test group shall have rheumatism or corresponding disorders influencing strength and function of hands.

Performing test
The test is carried out as arranged sessions with Danish Rheumatic Association and Senior Associations.
1. If the person is accepted according to strata the test person is asked to reply to a questionnaire for personal information (*Appendix 4B*).
2. The person’s strength is measured according to the procedure (*Appendix 4B*). The test includes grip strength, pinch strength: 1) Tip pinch, 2) Key pinch, 3) Palmar pinch (three fingers) and wrist strength.
3. The supervisor is responsible for filling in the measurement results (*Appendix 4B*).
4. The opening test is performed according to the following procedure: The test person is given one packages without opening instruction. Each person is provided 5 min. to try to open the package. If the person is NOT able to open the packages within the 5 min, instruction is given and the person may try aging provided only 1 min. If the person is successful within these time limits, the package gets a pass. The supervisor is responsible for filling in the measurement results (*Appendix 4B*).
5. The test person is asked to reply to a questionnaire regarding easiness of handling the packages (*Appendix 4B*). The judgment of easiness returns a score from 1 to 5, with 1 as easy and 5 as difficult. The package from the previous test is re-used. If any of the steps are too difficult for the test person within 1 minute the supervisor is allowed to help in order to reach the next step.
6. The test person repeat step 3 and 4 until the 4 packages has been tested, according to randomization of samples.

Equipment for hand strength measurement
- Hand-held grip strength dynamometer (North Cost Medical, Precision Instruments, USA)
- Hand-held pinch strength dynamometer (North Cost Medical, Precision Instruments, USA) for pinch strength: 1) Tip pinch, 2) Key pinch, 3) Palmar pinch (three fingers)
- Bottle tester, TORNADO (JKM systems, DK) for wrist strength measurement including glass jar of 70 mm lid diameter
3.4.2.2.3 Results

**Strata**
The aim of collecting test persons was fulfilled, according to the strata outlined (method section). Only an overweight of males appear in questions of “no disabilities” and “problems with packages” when considering the aimed consistence of 2/3 females and 1/3 males. The age versus gender distribution is shown in Fig. 13.

**Strength measurements**
The dominating trends in the strength measurements is large effect of gender and age, but the effect of age is not consistent of all results due to too small population size for single intervals. Thus, the females and older people have less strength. The effect of disability was less dominating caused by the fact that, all test persons were active seniors and were living in homes of there own. (*Appendix 4B*).

**Time keeping**
Most test persons were able to open four of the eight packages within 15 seconds. Those four packages were K Medicine, L Ham packages, M Milk container and S Tin. They were all opened within 45 seconds except two tests with the S Tin and two tests with the K Medicine. The R BiscZipper and most of the X BiscTearStrip packages were opened within 90 seconds. The opening time of the V Candies had a homogeny distribution of each interval until 120 seconds. 10 test persons of 34 in total never succeed in opening the T Coffee packages. For those tests that did succeed most T Coffee packages were opened within 210 seconds (*Appendix 4B*).

**Score of easy opening**
The package is judged as easy or difficult due to the average of scores according to limit score 3. Thus, average score in the interval 1-3 results in easy open pack and 3-5 as difficult. The results of the first question: “What is it like to open the package for the first time”, appear in Table 3 (*Appendix 4B*). The opening procedure was the only operation that caused problems for the test persons.

**Table 3.** Results of judgments of the easiness in open the eight packages. The average score in the interval 1-3 results in easy open pack and 3-5 as difficult.

<table>
<thead>
<tr>
<th>Package</th>
<th>1 Medicine</th>
<th>2 Ham</th>
<th>3 Milk</th>
<th>4 BiscZipper</th>
<th>5 Can</th>
<th>6 Candy</th>
<th>7 Coffee</th>
<th>8 BiscTearStrip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judgment</td>
<td>Easy</td>
<td>Easy</td>
<td>Easy</td>
<td>Easy</td>
<td>Easy</td>
<td>Difficult</td>
<td>Difficult</td>
<td>Easy</td>
</tr>
</tbody>
</table>

![Figure 13. The age distribution of all 61 test persons.](image)
3.4.2.2.4 Discussion and conclusions

The control group
The control group was selected on the behalf of the test persons own expression of: “no problems with opening of packages”. However, due to test results, it was not possible to find a clear indication that those people finds the tested packages easier to open compared to the test group. However, most of the control group was categorised in the stronger half of the total test population, especially in the case of wrist strength and pinch strength with three fingers.

With the assumption that the control group truly has less difficulties with packages in general than the test group, the results of the control group indicate that strong grip strength is not as important as finger strength. It is difficult to conclude the effect of wrist strength as this ability was less tested due to the choice of package with screw caps demanding little force (see section of mechanical measurements).

Comparing time keeping and scores for easy opening
Fig. 14 shows good correlation between use of time in opening of package and score of easy opening. The point for the R BiscZipper box (no. 4 at the Fig. 14) does not match the rest of the measurements because the opening procedure includes two operations which increase time consumption during opening. This indicates a possible risk of fail if using time as pass code. However, the R BiscZipper is the only package including two individual package parts (box and bag inside). Thus, the test persons may easily consider the test as two separated tests, which explain why the test persons has returned the score of 2, even though the opening time was approximate twice as long as expected according to Fig. 14. If the opening time is halved for the R BiscZipper the mark fits the rest of the package measurements.

![Figure 14. The function of the average score of easy opening and the corresponding average time for opening of each package.](image-url)
Comparing mechanical force and scores for easy opening

The function of the average score of easy opening and the corresponding average mechanical force for opening of each package is shown in Fig. 15. For packages with more than one opening operation the measurement of the operation with the largest required force is used.

When comparing mechanical force with scores for easy opening the picture of Fig. 15 seems confusing without dominating directions. This indicates poor correlation between score of easy opening and force requirement. K Medicine and V Candies do not comply with the expected position in Fig. 15. K Medicine is judged as too easy and V Candies as too difficult compared to the required force for opening. Thus, the mechanical measurement is not useful as judgment parameter as itself.

The difficulties with V Candies illustrate an important issue rooted in the lack of knowledge of the test persons in how to open the package correctly. This shows that, if the necessary disposal strength is present, it is not certain that the test person is able to open the package easily. This will only be discovered when persons are used as "test instruments" and no instruction is given before the test run.

Figure 15. The function of the average score of easy opening and the corresponding average mechanical force for opening of each package.

Comparing time of opening and pinch strength

The function of the individual test person’s lateral pinch strength and the corresponding specific time for opening of each package is shown in Fig. 16 and 17. Marks at 300 seconds are indicating fail in opening of the package, as 300 seconds is the maximum available time for the opening test.

The results in Fig. 16 show the correlation between the lateral pinch strength and the opening time. The effect of strength in the fingers is clear as more pinch strength is resulting in faster opening of the package. The function is marked out as a “V-shaped cloud” instead of a “line” for each sample set showing large variation in ability of compensating of forces for test persons of low strength. This shows the most fundamental reason why measurements of a test person’s strength is not an accurate method in evaluating a test person’s ability to open a package, because most people will try to compensate in opening the package with use of strength from other muscle groups.
Fig. 17 shows the limit of force that the test persons should have in order to be able to open the T Coffee package. This indicates that the test person must have pinch strength of at least 40-50 Newton in order to open the package. This correlates well with the mechanical measurement. The measurement showed that the T Coffee package required 45 Newton to break the seal. However, in this calculation the friction is not taken into account. The pull-ring of the S Tin and K Medicine both required mechanical opening forces of 50-60 Newton, but no large difficulties appeared for the test persons. This shows once more, that the force required is not decisive in success in opening of packages, but of course is it vital that the consumer has sufficient forces to open the package. The grip ability is also very important.

![Figure 16](image1.png)

**Figure 16.** The function of the individual test person’s lateral pinch strength and the corresponding specific time for opening of K Medicine, R BiscZipper and S Tin.

![Figure 17](image2.png)

**Figure 17.** Pass and fail in opening of the coffee package. The function of the individual test person’s lateral pinch strength and the corresponding specific time for opening of T Coffee.
3.4.2.3 Quantitative tests C

Raija-Liisa Heiniö/ VTT
Experimental studies by Finnish Rheumatism Association and VTT, data processing and reporting by VTT

3.4.2.3.1 Abstract

In general, most of the packages were evaluated as rather easy to open (mean over 6 on the scale from 1 to 9); in the case of most packages, over 80% of the participants did not perceive difficulties in opening the package. Coffee, candy and tin packages were exceptions – these were perceived the most difficult packages to handle. In terms of closing, the pill jar (K) and the milk carton (M) were the best. The ham package (L), pill jar (K), milk carton (M), and biscuit carton ® seemed most suitable for repeated use, except that closing of ham pack was evaluated as good. During the data collection the respondents showed some kind of expectations towards opening the packages; however, the opening mechanisms of the selected packages did not necessarily represent the typical case of that type of package.

Several different measures were used to evaluate respondents’ hand function. All of these seemed to measure much the same thing, and to relate to perceived easiness of handling the packages. Participants with more problems with their hand function perceived more difficulties in handling the packages. Especially, opening of the tin, ham, candy and milk packages were perceived as more difficult by those with weaker ability to take grips with the right hand. Whereas opening of the coffee and candy packages were perceived difficult by almost all participants irrespective of the hand function, and opening the biscuit carton was relatively easy for all. Respondents with more difficulties to take grip with their left hand more often perceived problems in taking a right dose from packages, which could not be emptied with one hand.

3.4.2.3.2 Background

This chapter describes the results from the Finnish consumer study. The aim was to describe how the study participants evaluated the easiness to open and handle eight food packages deviating in their opening mechanism. The questionnaire based on the draft of the European CEN standard (Packaging – Ease of opening – Criteria and test method for evaluating consumer packaging) was revised in cooperation with VTT Technical Research Centre of Finland and Finnish Rheumatism Association. The procedure to perform and practical guidance for running the consumer test was provided by VTT. The consumers in the test performed by the Finnish Rheumatism Association were adult consumers with reduced hand function. The consumer data were collected by the Finnish Rheumatism Association, and the data processing and reporting was carried out by VTT. The work was implemented between October and December 2007.

3.4.2.3.3 Method and procedure

The data was collected with hall tests, where participants were provided the same eight commonly selected food packages as in 3.3 Analytical sensory testing and in 3.4.2.2 Quantitative test B. for testing and evaluation. No additional tools were provided to the participants. There were two phases in the test procedure:

- self-evaluation of the hand function and demographic information (Appendix 4C)
- practical test evaluating the ease of opening of packages (Appendix 4C)
The study was targeted to consumers (N=87) with potential difficulties in package handling. Most participants were elderly (mean age 60 years) females. Roughly 30% of them indicated having at least some problems with their hand function.

3.4.2.3.4 Results

Hand function survey
Several different types of questions were used to chart respondents’ hand function and pain perceptions (Appendix 4C). Participants evaluated their overall hand function, four aspects of their right hand function, pain in their right and left hand, and ability to take various grip positions. Based on these measures, roughly a third of the respondents had at least some problems with their hand function. More detailed results are presented in Appendix 4C.

Hand grip evaluations
A questionnaire with pictures was used to evaluate which kind of grips (pinch, key, pen, five fingers, diagonal, transversal) were difficult for the respondents Appendix 4C. Factor and correlation analysis suggested that if the person has difficulties in taking one of these grips he/she is likely to have difficulties in the other grips, too. Thus, the questions seem to measure much the same thing, and grip indices were calculated for right and left hand, respectively, as means of all six questions per hand.

Results from the evaluation of sample packages
In general, most of the packages were perceived as being rather easy to open; most mean ratings were higher than 6 (Table 4), and in the case of most packages, over 80% of the participants did not perceive difficulties in opening the package (Fig. 18). Coffee, candy and also tin packages were exceptions. Especially, coffee (T) and candy (V) packages were clearly the most difficult to handle (open, re-open, close and take a dose from). Over 90% of the participants considered the coffee package as difficult to open (Fig. 18), and 27 and 14 respondents, respectively, were not able to open the coffee and candy packages at all. The package of digestive biscuits (X) was perceived as being easiest to open, but not easy to close. In terms of closing, the pill jar (K) and the milk carton (M) were the best. Since one cannot really close a tin or a candy bag, they were naturally estimated as difficult to close. However, also coffee package was difficult to close for the respondents in average. The ham package (L), pill jar (K), milk carton (M) and biscuit carton Tapini (R) seemed most suitable for repeated use, except that closing of ham package was evaluated as good (Table 4). The results by each sample package and influence of hand function on handling the packages are presented in Appendix 4C. A PCA (principal component analysis) plot of the consumer data is presented in Fig. 19. All the questions used in the consumer study are grouped together and apart from the package samples, indicating that all questions are measuring approximately the same dimensions of opening the packages.
Figure 18. Percentages of respondents who indicated difficulties in opening the package. Overall difficulty of opening (questions 4, 10, 16 etc.) scores 1 – 4 are included.

Table 4. Perceived easiness of handling the sample packages. Means (bold text) and standard deviations.

<table>
<thead>
<tr>
<th></th>
<th>K Pharm.jar</th>
<th>L Ham</th>
<th>M Milk</th>
<th>R Tapini</th>
<th>S Tin</th>
<th>T Coffee</th>
<th>V Candy</th>
<th>X Digestive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open 1.time</td>
<td>5.5</td>
<td>6.3</td>
<td>5.9</td>
<td>6.7</td>
<td>5.7</td>
<td>1.4</td>
<td>3.4</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>2.1</td>
<td>1.9</td>
<td>2.1</td>
<td>1.7</td>
<td>1.8</td>
<td>1.4</td>
<td>2.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Close</td>
<td>7.1</td>
<td>5.5</td>
<td>6.6</td>
<td>6.0</td>
<td>3.2</td>
<td>3.3</td>
<td>2.7</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
<td>2.4</td>
<td>1.7</td>
<td>2.1</td>
<td>2.5</td>
<td>2.2</td>
<td>2.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Open 2.time</td>
<td>7.3</td>
<td>7.4</td>
<td>7.2</td>
<td>7.2</td>
<td>5.9</td>
<td>3.6</td>
<td>4.9</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td>1.7</td>
<td>1.5</td>
<td>1.6</td>
<td>2.6</td>
<td>3.3</td>
<td>3.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Overall estimate</td>
<td>6.2</td>
<td>6.4</td>
<td>6.1</td>
<td>6.6</td>
<td>5.4</td>
<td>1.6</td>
<td>3.2</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
<td>1.6</td>
<td>1.8</td>
<td>1.6</td>
<td>2.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Take a dose</td>
<td>6.7</td>
<td>6.6</td>
<td>6.7</td>
<td>6.8</td>
<td>6.3</td>
<td>5.4</td>
<td>5.8</td>
<td>6.8</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>1.7</td>
<td>1.7</td>
<td>1.5</td>
<td>1.6</td>
<td>2.2</td>
<td>2.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Empty</td>
<td>7.5</td>
<td>7.3</td>
<td>7.3</td>
<td>7.1</td>
<td>6.3</td>
<td>6.1</td>
<td>7.2</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>1.3</td>
<td>1.5</td>
<td>1.5</td>
<td>1.7</td>
<td>2.2</td>
<td>1.9</td>
<td>1.7</td>
</tr>
</tbody>
</table>
3.4.2.3.5 Conclusion

Coffee and candy packages used in this study were perceived clearly as the most difficult packages to handle, independent of the hand function of the respondent. This may be due to the specific features of the samples used in this study, and thus the result cannot be generalized to all coffee and candy packages. Handling of the tin package was also perceived difficult by a part of the respondents. In average, all other packages were estimated as being more easy than difficult to handle.

According to the PCA analysis all the questions used in the consumer study seemed to measure approximately the same dimensions of opening the packages.

In general, respondents with more deficiencies in their hand function experienced more difficulties with all package types than those with normal hand function ($F(1)=9.06; p=0.004$). Respondents with deficiencies in hand function seemed to have more difficulties in opening especially the tin, but also the milk and ham packages, compared to those with better hand function.

The different measures of hand function had high correlations with each other, suggesting that they all measured about the same thing.
4 Discussion

In this chapter all data is evaluated; first as a summary of the results, followed by evaluating the relevance of the test methods used (mechanical, sensory and consumer studies). The selected eight package samples were commonly chosen to represent the variability of food packages regarding their opening. Only in the consumer test A (data processing by cluster analysis) the sample packages were five packages with a similar opening mechanism, a screw cap. However, K Medicine was included in all tests.

All test persons used in the consumer tests and in qualitative laddering suffered from reduced hand function. The test persons for the consumer studies were selected on the criterion expressed problems with packages, test persons age between 50-90 year old and gender distribution with 1/3 of males and 2/3 females. Thus, the target group was very loosely defined. The target group for the focus group study was very different as it required test persons with more than 50% reduced hand function and a variety of different types of diseases represented. The age restriction is pointed out, as elderly people are more likely to experience problems with package and especially females. But both children and younger persons with diseases influencing hand functionality do also experience trouble with packages. However, you have to draw the line.

In addition to the criterion on hand function, the number of test persons have an impact on the reliability of results.

4.1 Summary of the results and the principle of test methods

4.1.1 Mechanical tests

The mechanical tests are measuring the force needed to open the packages. The measurements have purpose of providing the lower limit of strength needed when consumers are opening the packages. However, as the measurements do not truly imitate human grip of the package it can only be used as an indication of the level of force needed, and the measurement failure caused by that is different from package to package. The level of the failure dependents on factors like grip ability, material slipperiness and the type of opening mechanism of the packages and those factors are not included in the mechanical test.

The rank order of the package samples from difficult to easy to open in the mechanical test was: K Medicine, S Tin, T Coffee, M Milk, L Ham, R BiscZipper, X BiscTearStrip, V Candies.

4.1.2 Analytical sensory study

In the qualitative laddering technique the pictures of the samples are grouped and sorted according to the judgment of the test person’s opinion of easiness to open the packages. The technique gives an idea of what consumers think of packages and their perceptions. It points out potential problems, and is a good aid in a development situation. From the sample packages R BiscZipper and X BiscTearStrip were perceived to be easiest to open, whereas T Coffee was most difficult and the other packages between these. Clear visibility was a very important issue along with grip ability and strength needed.
By the sensory profiling it is possible to collect all relevant information concerning the easiness to open packages, and thus, form an overall view of the aspects influencing the openability. However, sensory profiling does not as such take sides on the acceptance regarding the easiness to open. The method provides information of the package performance compared to other packages related to the specified attributes. Sensory profiling is especially efficient in product development. If necessary, acceptance criteria for the attributes can be developed with the help of the consumer test.

Sensory profiling does not directly rank the packages based on the easiness to open. Though the rank order of the package samples from difficult to easy to open in the analytical sensory test could be: T Coffee, K Medicine, S Tin, L Ham, M Milk, R BiscZipper, X BiscTearStrip, V Candies. However, V Candies and also X BiscTearStrip were assessed as being difficult to open due to the poor visibility and clarity of the opening mechanism. Reasons for the poor performance of T Coffee were the strength needed and tightness of the opening mechanism and the rigidity of the packaging material.

The results of the mechanical measurements were well related to the sensory rank order of the strength needed for opening the packages. The only significant difference is the rank order of T Coffee, but the mechanical result may be related to other measured attributes, such as grip ability or slipperiness of material. This shows that the sensory panel is well trained.

The laddering technique was used here only for eliciting the descriptive attributes and it is not necessary to repeat that step any more. However, the sensory attributes must describe the deviations among the packages to be studied, and thus, the vocabulary must always be checked and modified if necessary prior the sensory profiling.

4.1.3 Consumer studies

Consumer tests include the focus group testing and three quantitative tests.

4.1.3.1 Focus group testing

The test group in the focus group testing was a mixed group of consumers with different kind of reduced hand functions. The consumer test is performed with instruction before the individual test. The test person is asked to reply to a questionnaire regarding easiness of handling the packages (score from 1 to 9, with 9 as easy and 1 as difficult). In question of the T Coffee, it was allowed to use a scissors to open the package. Questionnaires and exercises are used to document the hand function.

The results of the hand function test showed that it may not be necessary to measure all grips, because they measure almost the same thing. Thus, when a test person have trouble with one of the grips they are likely to have trouble with other grips.

The overall judgment rank order of the package samples from difficult to easy to open in the focus group test was: T Coffee, M Milk, K Medicine/ S-Tin, L Ham, X BiscTearStrip, R BiscZipper, V Candies. V Candies, X BiscTearStrip were accepted, and R BiscZipper failed in opening the inner seal (score 4.7). In spite of being easy to open, the opening mechanism of V Candies was identified as being difficult to find.
Pass code of the package was when the mean value of each question was 5 or more for each handling step. If only one question had one or more question with a score less than 5, the package failed. Thus, all questions were weighted as equally important.

4.1.3.2 Quantitative tests

Quantitative test A - Cluster analysis (SIK)
The test included the development of attributes, training and using a 10 cm graphic continuous line scale in evaluation. Cluster analysis was used to find possible groups or segments of consumers, and to characterise these groups more detailed. The groups with a hand dysfunction were not quite homogenous. Important were strength, age and gender, but as the strength ability is influenced of age and gender, strength may be the most important criteria. GAT and Grippit were used to evaluate the hand strength. The five sample packages were different from the other tests.

Quantitative test B - Consumer study (DTI)
The consumer test is performed without any opening instruction before the test. The test is performed with time keeping. The test person is asked to reply to a questionnaire regarding easiness of handling the packages (score from 1 to 5, with 1 as easy and 5 as difficult). The strength of the test persons is measured and included grip strength, pinch strength: 1) Tip pinch, 2) Key pinch, 3) Palmar pinch (three fingers) and wrist strength.

Measurement of the strength of fingers seemed to be more relevant than the grip strength. It is not possible to evaluate the maximum strength abilities of consumers, because weak persons will compensate the lack of hand strength with other muscle groups. The outcome of the questionnaire correlates very well with the time keeping, showing that experienced trouble of opening the first time is related to the time spend for opening the package. The same correlation is not found between strength needed and experienced easy opening, which makes the mechanical measurements less informative in question of easy opening evaluations.

The rank order of the package samples from difficult to easy to open overall judgment in the consumer test B was: T Coffee, V Candies, S Tin, K Medicine, M Milk, R BiscZipper/ X BiscTearStrip, L-Ham.

If score 3 is used as a pass code of the questionnaire overall judgment (of a scale 1-5), the T Coffee and V Candies did not pass the test, but all other packages were acceptable as regards to their opening.

Quantitative test C - Consumer test (VTT)
The consumer test was performed without giving any opening instructions to the test persons before the test. The test person was asked to reply to the questions in the questionnaire regarding easiness of handling the packages (scores from 1 to 9, with 9 as easy and 1 as difficult). If the respondent was not able to open the package at all, the rating 0 was given in data processing. Those who did not succeed to open the package did not evaluate the closing, taking a dose or emptying the pack. The hand function was asked from the test persons by a questionnaire as a self evaluation, which is similar to that used in the focus group testing.

The overall judgment rank order of the package samples from difficult to easy to open in the consumer test C was: T Coffee, V Candies, S Tin, K Medicine, M Milk, L Ham, R BiscZipper, X BiscTearStrip.
Opening of T Coffee and V Candies were difficult irrespective of the hand function. This shows that the trouble with V Candies was due to understanding/ finding the opening mechanism, and not due to lack of power. The question of overall judgment was used as pass criteria with a score of 5 or more. T Coffee, V Candies and S Tin were rejected, whereas the other packages passed.

4.2 Evaluation of the results of the screw cap packages

This chapter evaluates the data from Chapter 3.4.2.1 Analytical sensory data and Rheumatic patients’ consumer data and from Chapter 3.4.1 Focus Group.

- Analytical sensory data significantly discriminated the evaluated packages, 5 different jars with a screwing cap, Medicine the only package also included in our new tests, and there are two major aspects that are critical of the packages;

1. The opening mechanism
2. The movement necessary for opening and handling the package

Easiest to open was the Coffee followed by 60+. Somewhat more difficult was Medicine and most difficult spice and washing detergent. The coffee package was easy because it was easy to grip and handle as well as opening. 60+ was also easy to grip and needed less strength than Medicine for opening, where particularly the inner foil needed a lot of strength and a special gripping. The spice jar needed pincett grip, difficult to get hold of, but when you have done so it is easy to tear, in contrast to the washing jar easy to grip foil but harder to tear apart. See PCA below (see chapter 3.3.3.1 for viewing instructions);

Very distinct groups, coffee and 60+ near to easy to grip lid, easy to close and total easiness to open, Medicine, needed much more power to unscrew the lid, was difficult to grip the inner foil which also needed much more strength/power to open etc

- Large differences within the 100 group of rheumatic patients on how easy or difficult the package was to open. Four clusters were found;
Cluster 2; All quite easy, 27 %, with the largest proportion of men, lower average age, 60, and higher GAT values, 48, and less RA patients.
Cluster 4; All difficult, 23 %, only female, higher average age, 63, and lower GAT value, 41, and high proportion of RA patients.
Cluster 1; All quite easy except Medicine and Washing Powder jar, 30 %,
Cluster 3; Coffee and glass jar 60+ easy all the others difficult, 20 %, most female, average age 62, low GAT value, 41, mixed diagnoses

- Combining the analytical sensory data with the consumer data, cluster data, we see that the analytical panel is discriminating the packages much more than the consumers do. All consumer clusters are in the same area of the chart. See PLS below (see chapter 3.3.3.1 for viewing instructions).

![Graph showing PLS analysis](image)

This 100 group is used as a reference in the SRA method (Unicum method) proposed for CEN, Medicine reference package. In the SRA method the approval level is 5 on the 9-point scale (1=extremely difficult, 9=extremely easy), and with the mean values for the 100 group of rheumatism patients the coffee and washing powder packages should have been approved and not the others, Medicine is on the border line, and spice and 60+ not approved, which fits bad with the analytical sensory data. In the two last Figures above the mean values for the consumers are included for Opening first time, Opening second time and Openability. The last measure at least is correlated to the analytical sensory attribute Total openability.
4.3 Qualification of the different test methods

The qualification of the test methods used was evaluated by comparing the results obtained by the different mechanical, sensory and consumer methods by statistical multivariate techniques (PCA Principal Component Analysis and PLSR Partial Least Squares Regression).

Relating mechanical and sensory results shows that all sensory attributes are located together into the centrum of the PCA plot, whereas mechanical force directed to one corner of the plot and correlated with T Coffee and K Medicine packages (Fig. 20). Thus, measuring just the force gives a very narrow idea of all the aspects related to the easiness to open packages; it can be related only to the strength needed for opening.

![Bi-plot](image)

**Figure 20.** A PCA plot of the sensory and mechanical data for the eight common packages. The first principal component explains 92% of the variation of the results. Force1=step 1 and Force2=step 2 of the mechanical tests conducted by DTI. (See chapter 3.3.3.1 for viewing instructions)

Relating statistically the results of the analytical sensory study and the consumer study C (VTT) shows that the questions used in the consumer test are located close together on the left side of the PLS regression plot, and thus, measure all the same dimensions of opening the packages, i.e. keeping the grip from the package and the opening mechanism (Fig. 21). The question of easiness of closing the package is slightly apart from the other questions, and is related to the staying of the product inside the package. The sensory attributes are distributed widely among the sample packages indicating that the sensory descriptors used describe very well the deviations among the openability of the packages. High correlation is observed between clarity and visibility of the opening mechanism, and either of them (visibility) can be deleted from the glossary. Clarity of the opening mechanism is best in M Milk. T Coffee has a slippery packaging material and easily breaking opening mechanism. The package of V Candies is easily broken when opened.
The studies of Spenthult (focus group study), DTI (consumer study B) and Finnish Rheumatism Association-VTT (consumer study C) are compared in order to find the most appropriate method for evaluating easy opening of packs. As shown in Fig. 19 almost in all questions consumer study B judged the packages easier to open and handle than consumer study C and focus group study, next is consumer study C, and focus group study finds most of the packages most difficult. This correlates well with the outcome of calculating the percentages of failures of consumers in each consumer test (Table 5). The knowledge of the influence of strength abilities of consumers leads to the conclusion that the consumers of the test B are the strongest, next are the consumers of the test C, and the consumers of the focus group are the weakest. The grip strength was determined in slightly different ways in the focus group and consumer study, and only by using a self evaluation questionnaire in consumer test C. Thus, it is very difficult to get the order truly verified. However, measuring the strength is very important in order to understand the difficulties and to point out the target group.

During the consumer test trouble with the questions was observed especially when the handling was evaluated. The trouble was due to confusion in the meaning of the questions. For instance, is the

**Figure 21.** A PLS regression plot of the sensory and Finnish consumer study data for the eight common packages. The two first principal components explain altogether 99% of the variation of the consumer result and 48% of the sensory results. (See chapter 3.3.3.1 for viewing instructions)
package easy to close, when it have been broken? Some consumers may say “yes” and others “no”, because it requires no force but the result is not satisfactory done. The question needs to be more specific and simple. Like the sensory study the question was not only the tightness but also the slipperiness and visibility. Those attributes may be useful in the consumers test too.

The consumer test B also had time keeping during the opening of the package for the first time and this may be a solution to overcome the problems in judging easy even though the test person had a lot of struggle with the package before opening. If a test person is not able to open the package within at least 1 min. the package is too difficult, no matter if the opening mechanism is difficult to find or the sealing is too tight to open. In the test B most consumers was satisfied when the opening time was between 20-30 seconds, and most of the participant give up within 2 min.

Another issue is that the outcome in each step is dependent of the steps before, as if the package is not correctly opened. It may be more difficult to close, dose and empty the package than expected and, thus, influencing the results. To judge the package fair the starting point must be identical for all tests. This will explain the differences of the handling questions for instance between the test B results and test C results of the T Coffee (Fig. 22).

The questions in the consumer test reflect more on overall usability of the package, whereas the attributes used in the sensory test relate mainly to the easiness of opening, and not how to close, dose and empty the package. In the sensory test more descriptive attributes are used and thus, more detailed view on easiness to open packages is generated. The sensory panel is maybe not able to notice all difficulties faced by consumers. For example, some consumers broke the X BiscTearStrip package from the top although the sensory panel judges the clarity to be 7.8. Correlation between the target consumer groups and the appropriate attributes is very important in order to use sensory panels. The attributes may also vary from time to time. The most crucial scenario is when a totally new opening mechanism is tested. Therefore, it is important to check - and also modify, if necessary – the sensory descriptors prior the assessments.

Table 5 Percent of failure in opening the package the first time of the studies of focus group (Spenthult), consumer test C (Finnish Rheumatism Association-VTT) and consumer test B (DTI).

<table>
<thead>
<tr>
<th></th>
<th>K Medicine</th>
<th>L Ham</th>
<th>M Milk</th>
<th>R BiscTap.</th>
<th>S Tin</th>
<th>T Coffee</th>
<th>V Candies</th>
<th>X Bisc Dig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus group</td>
<td>22.0%</td>
<td>9.0%</td>
<td>18.0%</td>
<td>14.0%</td>
<td>23.0%</td>
<td>82.0%</td>
<td>5.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Consumer test C</td>
<td>2.3%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1.1%</td>
<td>31.0%</td>
<td>16.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Consumer test B</td>
<td>2.9%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>3.4%</td>
<td>20.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
Figure 22. Comparison of the results of questions of the questionnaire of easy handling of the package. The Scores of DTI is translated to a 9 point scale and turn around making 1 as most difficult and 9 as most easy. The judgment of Spenthal R BiscZipper, opening the package the first time is an average of the outer and inner package of score 6.9 and 4.7 respectively.
5 Conclusions

Various characteristics of food packages are nowadays good, including their safety aspects. However, a novel problem has arisen: how to open the package easily. This is a challenge not only to consumers with reduced hand function, but it is common for all of us to face every now and then difficulties in opening packages. Especially adult consumers with reduced hand function, such as rheumatic or elderly people, or children are familiar with this issue. But what makes it easy to open a package, and what are the most critical factors for consumers in opening packages?

The aims of the Easyopenpack project were
- To screen physical qualifications and capabilities of consumers to open packages easily
- To search critical aspects in opening different types of food packages
- To identify the most relevant method(s), which has (have) the necessary qualifications for providing the basis for the final test method
- To inform, interest and involve Nordic companies in product development work
- To collect scientific background information for the CEN (European Committee for Standardization) work for developing the test method

5.1 Physical qualifications and capabilities of consumers

When the capability of handling packages is concerned from a consumer point of view, there are several factors possibly influencing on the easiness to open packages. These are reduction in hand strength, in sensibility/sensitivity, in dexterity and in power grip, left or right-handed, co-ordination difficulties, shaking, pain, medical treatment visual capability, cognition and personality.

Different movements and capabilities are required from consumers to fend from the opening process and handle successfully the packages. Forbidden physical paths are key pinch grip, use of power and twisting or rotation of wrist. Avoided physical paths are pulling, lifting and pushing by using power, whereas allowed is pulling with straight wrist, lifting and pushing with straight wrist and pressing.

5.2 Critical aspects in opening different types of packages

A wide variety of different types of opening mechanisms of food packages exist. Eight commonly used food packages were selected for the experiments, and these eight packages represented very well the distribution among different types of food packages with various opening mechanisms.

The most critical attributes for evaluating the easiness to packages turned out to be
- visibility and clarity of the opening mechanism,
- keeping the grip from the opening mechanism,
- tightness and breakage of the opening mechanism,
- strength needed to open the package,
- need to use both hands in opening,
- rigidity and slipperiness of the packaging material,
- keeping the grip from the package,
- breakage of the package while opening, and
- degree of product staying inside the package after opening.
5.3 Qualifications of test methods

The easiness to open these packages was evaluated by several mechanical, sensory and consumer studies.

The mechanical test proved to be rather quick, easy and cheap to implement. It is also easily repeatable but does not imitate human action. Mechanical test measures only one dimension (strength), and necessitates specific equipment.

By sensory assessment, a whole view of easiness to open packages can be formed. Sensory test imitates human action, and is easily repeatable. However, it is also rather time-consuming, expensive, and requires a well-trained panel.

By a consumer study actual target groups can be imitated if recruitment criteria are well defined. Consumer test is culture-/ target group-dependent. It is also rather time-consuming, expensive, not easy to implement, and difficult to repeat if the procedure is not controlled. The recruitment of the test group is crucial, and usually a big test group (n~100) is needed. Simple and specific phrasing of the questions is critical for getting reliable results, and standardised and specified test design is essential.

Thus, mechanical test is not recommended alone for a test due to the very narrow view of measuring easiness to open packages. Sensory and consumer tests could be usable. However, in sensory test the descriptive attributes mentioned in chapter 5.2 must always be checked prior the assessments. In addition, correct criteria (questions to be related to the critical sensory attributes) must be determined for the consumer test, and the consumer panel must be big and representative enough. The possibility to drastic bias exist, if the procedures to perform the tests are not well and extremely detailed defined.

One of the objectives of this project was to create scientific basis for the development of the test method for the European CEN standard. The goal was not to give recommendations or to set any acceptance criteria for assessing the easiness to open packages as this belongs to the standardisation committee.
6 Literature


Standard drafts
## Appendix 1

### Appendices to the chapter 3.2 Mechanical tests

**Table 1.** Results of Danish Technological Institute performed on the eight packages for test.

<table>
<thead>
<tr>
<th>Package/Step</th>
<th>Average Force at peak Newton</th>
<th>Min Force at peak Newton</th>
<th>Max Force at peak Newton</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can – 1.step (turning ring)</td>
<td>11,6</td>
<td>11,3</td>
<td>12,2</td>
<td>0,3</td>
</tr>
<tr>
<td>Can – 2.step (pulling ring)</td>
<td>49,3</td>
<td>47,4</td>
<td>50,3</td>
<td>1,1</td>
</tr>
<tr>
<td>Box for Tapini – 1.step</td>
<td>5,1</td>
<td>4,4</td>
<td>6,0</td>
<td>0,6</td>
</tr>
<tr>
<td>Bag for Tapini – 2.step</td>
<td>2,5</td>
<td>0,6</td>
<td>7,9</td>
<td>2,4</td>
</tr>
<tr>
<td>Ham</td>
<td>8,4</td>
<td>5,6</td>
<td>17,5</td>
<td>3,5</td>
</tr>
<tr>
<td>Biscuit</td>
<td>3,4</td>
<td>0,7</td>
<td>6,3</td>
<td>1,3</td>
</tr>
<tr>
<td>Milk – 1.step (separate wings)</td>
<td>23,9</td>
<td>19,9</td>
<td>29,6</td>
<td>3,0</td>
</tr>
<tr>
<td>Milk – 2.step (forming spout)</td>
<td>20,3</td>
<td>8,9</td>
<td>36,2</td>
<td>8,8</td>
</tr>
<tr>
<td>Coffee</td>
<td>44,9</td>
<td>29,9</td>
<td>61,0</td>
<td>9,9</td>
</tr>
<tr>
<td>Candy</td>
<td>9,3</td>
<td>5,5</td>
<td>18,2</td>
<td>4,0</td>
</tr>
<tr>
<td>Medicine – 1.step (cap) N*m</td>
<td>0,89</td>
<td>0,60</td>
<td>1,27</td>
<td>0,25</td>
</tr>
<tr>
<td>Medicine – 2.step (pull-ring)</td>
<td>62,8</td>
<td>58,5</td>
<td>66,7</td>
<td>2,9</td>
</tr>
</tbody>
</table>

**Table 2.** Results of Stora Enso performed on all packages for test except Medicine.

<table>
<thead>
<tr>
<th>Package/Step</th>
<th>Average Force at peak Newton</th>
<th>Min Force at peak Newton</th>
<th>Max Force at peak Newton</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can – 1.step (turning ring)</td>
<td>11,2</td>
<td>10,6</td>
<td>11,6</td>
<td>0,4</td>
</tr>
<tr>
<td>Can – 2.step (pulling ring)</td>
<td>43,7</td>
<td>39,3</td>
<td>50,3</td>
<td>4,2</td>
</tr>
<tr>
<td>Box for Tapini – 1.step</td>
<td>4,7</td>
<td>4,2</td>
<td>5,1</td>
<td>0,5</td>
</tr>
<tr>
<td>Bag for Tapini – 2.step</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ham</td>
<td>9,7</td>
<td>7,9</td>
<td>12,4</td>
<td>1,7</td>
</tr>
<tr>
<td>Biscuit</td>
<td>3,7</td>
<td>2,8</td>
<td>5,0</td>
<td>0,8</td>
</tr>
<tr>
<td>Milk – 1.step (separate wings)</td>
<td>24,4</td>
<td>22,0</td>
<td>23,2</td>
<td>2,6</td>
</tr>
<tr>
<td>Milk – 2.step (forming spout)</td>
<td>9,1</td>
<td>7,0</td>
<td>12,0</td>
<td>1,8</td>
</tr>
<tr>
<td>Coffee</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Candy</td>
<td>2,8</td>
<td>1,9</td>
<td>3,6</td>
<td>0,7</td>
</tr>
</tbody>
</table>

**Table 3.** Results of Tetra Pak performed on Medicine.

<table>
<thead>
<tr>
<th>Package/Step</th>
<th>Average Force at peak Newton</th>
<th>Min Force at peak Newton</th>
<th>Max Force at peak Newton</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicine – 1.step (cap) N*m</td>
<td>0,47</td>
<td>0,24</td>
<td>0,75</td>
<td>0,13</td>
</tr>
<tr>
<td>Medicine – 2.step (pull-ring)</td>
<td>56,1</td>
<td>51,4</td>
<td>59,7</td>
<td>2,5</td>
</tr>
</tbody>
</table>

**Table 4.** Results of Tetra Pak performed on Medicine.

<table>
<thead>
<tr>
<th>Package/Step</th>
<th>Average Energy Newton*meter</th>
<th>Min Energy Newton*meter</th>
<th>Max Energy Newton*meter</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicine – 2.step (pull-ring)</td>
<td>1,3</td>
<td>0,8</td>
<td>2,0</td>
<td>0,4</td>
</tr>
</tbody>
</table>
Mechanical tests by Danish Technological Institut

The equipment used is Instron 5569 torque meter. Test type is Tensile and the crosshead speed is 100 mm/min with full scale load range of 5.0000 kN. Bottle tester, TORNADO (JKM systems, DK) was used to measure the torque during cap opening of Medicine.

**K Medicine**
The test contains two steps: 1) cap opening and 2) Pull-ring.
The package was fastened to the measurement cell. The cap is loosened by manual power and the maximum torque required is measured.

1. step in cap opening of Medicine

2. step in opening the Medicine with pull-ring

**L Ham**
Ham and most of the tray is removed before test. The material of the lower slip is brittle and for that reasons the slip is bend before testing. The slips are pre-paraded by tape, due to low friction, and the slips are prolonged by clips in order to provide grip area for the test equipment.

Opening of ham package

**M Milk**
The sample is emptied out for milk and only the gable top is used for test. The test contains two steps: 1) Separating the wings and 2) Pulling, forming the spout.

In order to insure natural replacement of the force during the opening process the grabs of the equipment are replaced by strings. The strings are fastening by holes in the paperboard of the sample. The position of the hole is essential for the performance of the opening process (see pictures 1 and 2).
The test contains two steps: 1) paper box with tear strip and 2) bag of metallic foil. The opening force of the bag was tested with use of the “trouser method”. The “trouser” is made by cutting from the opposite side of the package without cutting the seal (picture). This makes slips for the machine to get a grip and perform the test of the tear strength.

2nd step in opening the Tapini foil bag using “trouser method”.

R BiscZipper
S Tin
Due to the opening procedure is a gliding process with continuous displacement of the force, it is impossible to construct a similar mechanical test without special equipment. The angel of the pulling is essential for the force applied. At least two steps are necessary: 1) Bending the ring and 2) opening the can by pulling.

The mechanical test is performed with only one angel of the force, but a $45^\circ$ angle from two sides. A wooden block shaped with a whole fitting the diameter of the can and with a $45^\circ$ angle of the “floor” is produced in order to control the position of the sample during test.

1st step in turning the ring

2nd step in opening the package

T Coffee
The sample preparation implies cutting the top of the packages in two parts (two separate sets of wings). The equipment grip is closed around the tip of each wing forming the $45^\circ$ angle. When the package is broken, the measurement stops. The peeling step is not included in the mechanical test.

Two other test set-ups are tried: 1) Vertical pull including one tip of each set of wings and 2) seal strength at the part in the middle. Both those set-ups are failures.
Opening the coffee package

**V Candies**
The test method is by use of “trouser method”, which implies making “trouser” by cutting from the opposite side of the package without cutting the seal (picture). This makes slips for the machine to get a grip and test the tear strength.

Opening the candy package with using ”trouser method”

**X BiscTearStrip**
The sample was fixed with the slip for easy opening placed as shown in picture. A string was fasten with tape at the easy open slip before performing the test.

Opening the biscuit package
Mechanical tests by Stora Enso

Test methods: The equipment used in the tests is a tensile tester model Zwick ZN 010. The setting for the equipment is based on standard test procedures and programs. Machine speed is at test 500mm/min. On several of the packages the opening procedure is a moving/gliding process with continuous displacement of the force, the angle of the pulling is important for the force applied. A special equipment where used for this, i.e. rail with a low friction sleigh. Tests involve a correction curve used in the machine (the force needed to move the wagon not included in the results). Milk container and metallic can it was necessary to open the packages in two sequences.

Picture1: Zwick tensile tester

Picture2: Rail with a low friction sleigh

L Ham
Package description: Plastic tray with a plastic tear of top.
Mechanical test: Equipment; rail with a low friction sleigh where used to obtain the right angel.

M Milk
Package description: Paper container of 1 liter milk (type Gable Top).
Mechanical test: only the top of the package where used in the test. The test where performed in two sequences: 1) separating the wings. To obtain the right angel during the test holes and strings where used. 2) Forming/pulling out the spout. Holes, strings and a hook where used.
**R BiscZipper**
Package description: Paper box with a tear strip on the top of the package.
Mechanical test: The equipment; rail with a low friction sleigh

**S Tin**
Package description: metallic can with a ring for easy opening.
Mechanical test: A wooden block where shaped to hold the can in the angle 45°. The test where performed in two sequences: 1) Bending the ring. To obtain the right angel during the test a string where used. 2) Opening the can by pulling of the lid.
T Coffee
Package description: Coffee in block, vacuum packed in metallic foil.
Mechanical test: We did not manage to open the package in the right way with the tensile tester or manually with our hands. In the right way we mean that it should be possible to close the package again and the material should not be broken. The problem where that the sealing is to strong so the material around the sealing breaks before the sealing.

V Candies
Package description: Candy in plastic bag, tear initial starting point for easy opening.
Mechanical test: standard grips for the tensile tester. Tape where used for easy attach in the grips.

X BiscTearStrip
Package description: AL-foil with tear strip.
Mechanical test: The equipment; rail with a low friction sleigh where used to obtain the right angel. The tear strip where cut out and taped plane on the sleigh.
Mechanical tests by Tetra Pak

Method: Screw cap opening torque
An Instron torque meter is used to measure the torque during cap opening. The package is placed in a fixture attached to a plate that registers the torque while a rotating fixture opens the cap (Figure 1). The cap is opened with 4320 degrees/min.

Method: Pull-ring membrane opening force
A Zwick machine is used to measure the force when opening the pull-ring membrane. A fixture is holding the package at 20 degrees and the pull-ring is fastened in a clamp attached to a moving crosshead (Figure 2). The crosshead moves upward at a speed of 100 mm/min and the force is measured by a load cell in the crosshead. The measurement end when the pull-ring membrane comes loose completely.

Results

Screw cap opening torque
The screw cap opening torque and force values for the 17 samples are presented in Figure 3 and Table 1. The highest torque values (torque at peak) are registered early in the opening procedure, at angles between 0.38 and 6.78 degrees. The average of the torque at peak values for the 17 samples is 0.47 Nm.

Figure 3. Torque at increasing angle for the 17 samples.
Table 1. Screw cap opening torque.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Torque at peak (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>0.547</td>
</tr>
<tr>
<td>Sample 2</td>
<td>0.336</td>
</tr>
<tr>
<td>Sample 3</td>
<td>0.510</td>
</tr>
<tr>
<td>Sample 4</td>
<td>0.545</td>
</tr>
<tr>
<td>Sample 5</td>
<td>0.449</td>
</tr>
<tr>
<td>Sample 6</td>
<td>0.752</td>
</tr>
<tr>
<td>Sample 7</td>
<td>0.428</td>
</tr>
<tr>
<td>Sample 8</td>
<td>0.239</td>
</tr>
<tr>
<td>Sample 9</td>
<td>0.376</td>
</tr>
<tr>
<td>Sample 10</td>
<td>0.503</td>
</tr>
<tr>
<td>Sample 11</td>
<td>0.452</td>
</tr>
<tr>
<td>Sample 12</td>
<td>0.572</td>
</tr>
<tr>
<td>Sample 13</td>
<td>0.363</td>
</tr>
<tr>
<td>Sample 14</td>
<td>0.240</td>
</tr>
<tr>
<td>Sample 15</td>
<td>0.516</td>
</tr>
<tr>
<td>Sample 16</td>
<td>0.574</td>
</tr>
<tr>
<td>Sample 17</td>
<td>0.541</td>
</tr>
<tr>
<td>Average</td>
<td>0.47</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Pull-ring membrane opening force

The opening force values for the 17 pull-ring membranes are presented in Figure 4 and Table 2. Table 2 also includes values of the energy needed for opening the pull rings. Figure 8 shows a typical curve for pull-ring membrane opening, where the peak value represents the first break in the pull-ring membrane sealing. The average of the force at peak values for the 17 samples is 56.13 N.

9 of the packages were deformed during the pull-ring membrane opening as showed in Figure 9 and presented in Table 2.

![Figure 4. Force with increasing strain for one of the 17 samples.](image-url)
Table 2. Pull-ring membrane opening force.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Force at peak (N)</th>
<th>Energy (Nm)</th>
<th>Deformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>56.81</td>
<td>0.90</td>
<td>-</td>
</tr>
<tr>
<td>Sample 2</td>
<td>55.77</td>
<td>0.82</td>
<td>-</td>
</tr>
<tr>
<td>Sample 3</td>
<td>53.29</td>
<td>0.87</td>
<td>-</td>
</tr>
<tr>
<td>Sample 4</td>
<td>57.54</td>
<td>1.95</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 5</td>
<td>51.42</td>
<td>0.89</td>
<td>-</td>
</tr>
<tr>
<td>Sample 6</td>
<td>56.87</td>
<td>1.65</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 7</td>
<td>59.72</td>
<td>1.78</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 8</td>
<td>56.54</td>
<td>1.01</td>
<td>-</td>
</tr>
<tr>
<td>Sample 9</td>
<td>56.37</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Sample 10</td>
<td>51.94</td>
<td>0.85</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 11</td>
<td>59.09</td>
<td>1.67</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 12</td>
<td>56.41</td>
<td>1.86</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 13</td>
<td>58.75</td>
<td>1.75</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 14</td>
<td>57.86</td>
<td>0.98</td>
<td>-</td>
</tr>
<tr>
<td>Sample 15</td>
<td>56.89</td>
<td>1.62</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample 16</td>
<td>52.01</td>
<td>0.88</td>
<td>-</td>
</tr>
<tr>
<td>Sample 17</td>
<td>56.86</td>
<td>1.60</td>
<td>Yes</td>
</tr>
<tr>
<td>Average</td>
<td><strong>56.13</strong></td>
<td><strong>1.30</strong></td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td><strong>2.51</strong></td>
<td><strong>0.43</strong></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2

Appendices to the chapter 3.3 Analytical sensory testing

Attribute generation from the data of the consumer panel of SIK for descriptive profiling by a laddering technique. The counts for the reasons easy and difficult to open the packages were collected separately. The final attributes used were based on these counts.

<table>
<thead>
<tr>
<th>Packaging</th>
<th>Easy to open</th>
<th>Count</th>
<th>Difficult to open</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>K Pharmaceutical pot with screw cap 'Abbott'</td>
<td>Easy to draw from the ring</td>
<td>7</td>
<td>The ring too tightly fixed</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Easy to see the ring, easy to put the finger in</td>
<td>4</td>
<td>Difficult to open the cap, too tight</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Good grip</td>
<td>3</td>
<td>Too small</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>No needed wound, plastic good</td>
<td>2</td>
<td>Scissors needed occasionally</td>
<td>4</td>
</tr>
<tr>
<td>L Sliced ham in hard plastic package with removable plastic lid</td>
<td>Easy to draw</td>
<td>10</td>
<td>Bigger step would give better grip</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Easy to find the strip</td>
<td>8</td>
<td>Difficult to see the strip</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Soft material</td>
<td>6</td>
<td>Difficult to open the packaging</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Needs only little strength</td>
<td>5</td>
<td>Too tight sticking/gluing</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Needs a lot of strength</td>
<td>5</td>
<td>Needs a lot of strength</td>
<td>5</td>
</tr>
<tr>
<td>M Carton of milk</td>
<td>Easy to open</td>
<td>10</td>
<td>Needs two hands to be opened, two stages</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Easy to catch the strip</td>
<td>9</td>
<td>Too tight glue</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Stable packaging</td>
<td>8</td>
<td>Difficult to get the nozzle out</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Must know the trick to open</td>
<td>5</td>
<td>Scissors needed occasionally</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Does not need much strength</td>
<td>5</td>
<td>Bought in one large packages, scissors used</td>
<td>4</td>
</tr>
<tr>
<td>R Biscuits in carton box with tear strip</td>
<td>Good perforation, tear strip</td>
<td>20</td>
<td>Difficult to draw the whole tear strip away</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Easy to open</td>
<td>17</td>
<td>Too little strip</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Easy to see the strip</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paperboard is stable, good</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Needs only little strength</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S Ring pull tin</td>
<td>Easy to understand how to open</td>
<td>8</td>
<td>Difficult to lift the ring</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Good size in the ring</td>
<td>3</td>
<td>Risk to cut oneself, dangerous</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Openability depends on the material</td>
<td>3</td>
<td>Needs a lot of strength</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The ring may break</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hand material</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tin opener needed</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ring size must fit the finger</td>
<td>3</td>
</tr>
<tr>
<td>T Coffee in vacuum packaging</td>
<td>Easy to open</td>
<td>5</td>
<td>Difficult to open apart</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Easy to remove the tape</td>
<td>3</td>
<td>Scissors/knife needed</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No grip caught</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Too tight closure/glue</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difficult to remove the tape</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Needs a lot of strength</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Too little strip to draw</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Too glossy, slippery</td>
<td>3</td>
</tr>
<tr>
<td>V Candles in plastic laminate bag</td>
<td>Easy to see the strip</td>
<td>5</td>
<td>Difficult to open the bag</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Good tear strip</td>
<td>5</td>
<td>Too tight closure</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Easy to tear open</td>
<td>3</td>
<td>Difficult, depends on the material</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scissors/knife needed</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difficult to see the tear strip</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Too little strip to draw</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No grip caught</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Needs quite much strength</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The bag breaks</td>
<td>2</td>
</tr>
<tr>
<td>X Biscuits in light laminate foil</td>
<td>Very good tear strip</td>
<td>23</td>
<td>Difficult to see the tear strip</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Easy to open</td>
<td>18</td>
<td>The strip must be marked better</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scissors needed occasionally</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biscuits breaks to pieces</td>
<td>2</td>
</tr>
</tbody>
</table>
Sensory evaluation of the easiness to open packages

The selected attributes and their anchors
The scales were 10 cm in length, verbally anchored at each end, the left end corresponding to the lowest intensity (value 0) and the right side to the highest intensity (value 10) of the attribute. The attributes were divided regarding the opening mechanism (OM), packaging material (PM) and package (P) itself.

Opening mechanism

1 Visibility of the opening mechanism (Visibility OM): not visible at all – extremely visible
Evaluate the visibility of the opening mechanism visually.

2 Clarity of the opening mechanism (Clarity OM): not clear at all – extremely clear
Evaluate the clarity of the opening mechanism visually. A clear opening mechanism guides to open the package in an intended way. The opening instruction may be e.g. an arrow, the shape of the packaging or written instructions.

3 Keeping the grip from the opening mechanism (Keeping grip OM): grip not keeping at all – extremely keeping grip
Get hold the opening mechanism of the package according to the instructions (or in case the instructions are missing, in a best possible manner). A good grip from the opening mechanism aids in opening the package.

4 Tightness of the opening mechanism (Tightness OM): not tight at all – extremely tight
Evaluate the tightness of the opening mechanism (by hands). The less tight the opening mechanism is, the easier the opening of the package is. If you are not able to open the package at all, announce that in the evaluation sheet.

5 Breakage of the opening mechanism (Breakage OM): not breaking at all – extremely breaking
Evaluate, how much the opening mechanism will be broken while opening the package (by hands).

6 Strength needed to open the package (Strength need OM): not strength needed at all – extremely much strength needed
Evaluate, how much strength is needed to open the package (by hands). The more strength is needed, the more difficult it is to open the package.

7 Need to use both hands in opening the package (Need both hands OM): not at all – extremely much
Evaluate how much you actively need your both hands being able to open the package (by hands). If you only hold on to the package, the hand is passive.

Packaging material

8 Rigidity of the packaging material (Rigidity PM): not rigid at all – extremely rigid
Evaluate the rigidity of the packaging material in the opening situation by hands.

9 Slipperiness of the packaging material (Slipperiness PM): not slippery at all – extremely slippery
Evaluate the slipperiness of the packaging material in the opening situation by hands. It is difficult to get a good grip from a slippery material.

Package

10 Keeping the grip from the package (Keeping grip P): not keeping at all – extremely keeping
Evaluate, how good grip you get from the package when opening it.

11 Breakage of the package while opening (Breakage P): not breaking at all – extremely breaking
Evaluate, how much the package is broken when opening it.

12 Product staying inside the package after opening (Product inside P): not staying at all – extremely staying
Evaluate, how well the product stays in the package when opening the package.
Table 1. Means of the scores in the sensory profiling (n = 2 x 10). *-** Means on each row followed by a different letter signify that the samples are statistically significantly different in respect of that attribute (Tukey's HSD test; p < 0.05).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>K &quot;Mit-Val&quot;</th>
<th>L Ham</th>
<th>M Milk</th>
<th>R Bisc</th>
<th>Tapini</th>
<th>S Tin</th>
<th>T Coffee</th>
<th>V Candies</th>
<th>X Bisc</th>
<th>Digest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visibility OM</td>
<td>7.8&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>6.7&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>9.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.8&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.9&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5.9&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity OM</td>
<td>8.6&lt;sup&gt;abc&lt;/sup&gt;</td>
<td>6.9&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.2&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>8.0&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>2.8&lt;sup&gt;e&lt;/sup&gt;</td>
<td>7.8&lt;sup&gt;cd&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keeping grip OM</td>
<td>8.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.7&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.7&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightness OM</td>
<td>7.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.1&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>4.2&lt;sup&gt;de&lt;/sup&gt;</td>
<td>3.1&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>6.0&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>9.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.8&lt;sup&gt;fg&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;ef&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakage OM</td>
<td>0.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength need OM</td>
<td>7.0&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.9&lt;sup&gt;de&lt;/sup&gt;</td>
<td>4.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.7&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>5.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.0&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1.6&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need both hands OM</td>
<td>4.5&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>4.4&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>7.6&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>5.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>4.5&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>9.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.9&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3.6&lt;sup&gt;cd&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rigidity PM</td>
<td>7.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.3&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>5.7&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>4.5&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>7.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.8&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slipperiness PM</td>
<td>1.8&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>4.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.0&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3.0&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>1.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.5&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3.2&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keeping grip P</td>
<td>8.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>7.9&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>8.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8.6&lt;sup&gt;e&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakage P</td>
<td>0.1&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.1&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.4&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.9&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.2&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>5.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.4&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.8&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product inside P</td>
<td>9.0&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>9.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.1&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>6.8&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Sensory profiles of easiness to open the sample packages (n = 2 x 10).
Figure 2. Sensory profiles of packages by attributes ($n = 2 \times 10$).

Visibility OM

Clarity OM

Keeping grip OM
Appendix 3
Appendices to the chapter 3.4.1 Focus groups

Hand functionality

### Age

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40</td>
<td>3</td>
</tr>
<tr>
<td>40-49</td>
<td>1</td>
</tr>
<tr>
<td>50-59</td>
<td>6</td>
</tr>
<tr>
<td>60-69</td>
<td>9</td>
</tr>
<tr>
<td>&gt;70</td>
<td>3</td>
</tr>
</tbody>
</table>

### Diagnoses

- RA
- Artros MS
- Central Co-re Disease
- Sjögren's
- SLE
- Skleroderma
- Fibro

### Hand Functionality

<table>
<thead>
<tr>
<th>Strength</th>
<th>No. of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal strength</td>
<td>0</td>
</tr>
<tr>
<td>Slightly reduced</td>
<td>4</td>
</tr>
<tr>
<td>Great reduced</td>
<td>11</td>
</tr>
<tr>
<td>No strength</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agility</th>
<th>No. of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal agility</td>
<td>0</td>
</tr>
<tr>
<td>Slightly reduced</td>
<td>2</td>
</tr>
<tr>
<td>Great reduced</td>
<td>6</td>
</tr>
<tr>
<td>No agility</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coordination</th>
<th>No. of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal coordination</td>
<td>0</td>
</tr>
<tr>
<td>Slightly reduced</td>
<td>6</td>
</tr>
<tr>
<td>Great reduced</td>
<td>11</td>
</tr>
<tr>
<td>No coordination</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shakings</th>
<th>No. of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>No shakings</td>
<td>0</td>
</tr>
<tr>
<td>Slight shakings</td>
<td>4</td>
</tr>
<tr>
<td>Great shakings</td>
<td>11</td>
</tr>
<tr>
<td>Severe shakings</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feeling</th>
<th>No. of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal feeling</td>
<td>0</td>
</tr>
<tr>
<td>Slightly reduced</td>
<td>2</td>
</tr>
<tr>
<td>Great reduced</td>
<td>6</td>
</tr>
<tr>
<td>No feeling</td>
<td>11</td>
</tr>
</tbody>
</table>
Hand strength

Personer

Ham

Time extremely difficult. Score on a scale of 1-9:

1. How is it to grip the package?
2. How is it to open the package the first time?
3. How is it to take two slices of ham from the package?
4. How is it to reclose the package?
5. How is it to open the package a second time?
6. How is it to take the last slices from the package?
7. What is your total appraisal of handling the package?
1. How is it to grip the package?
2. How is it to open the package the first time?
3. How is it to pour one glass of milk?
4. How is it to reclose the package?
5. How is it to open the package a second time?
6. How is it to pour the last sip from the package?
7. What is your total appraisal of handling the package?

1=extremely difficult, 9=extremely easy
Tin

1. How is it to grip the package? 6.7
2. How is it to open the package the first time? 3.6
3. How is it to take mackerel from the package? 6.9
4. How is it to empty the package? 4.6
5. What is your total appraisal of handling the package? 4

Coffee

1. How is it to grip the package? 5.5
2. How is it to open the package the first time, not using any tools? 1.3
3. How is it to open the package with a pair of scissors? 6.4
4. How is it to take one measure of coffee from the package? 7.1
5. How is it to reclose the package? 4.2
6. How is it to open the package a second time? 5.9
7. How is it to take out the last coffee? 2
8. What is your total appraisal of handling the package? 5
Candy

1. How is it to grip the package?
2. How is it to open the package the first time?
3. How is it to take three pieces of candy from the package?
4. How is it to take the last piece of candy from the package?
5. What is your total appraisal of handling the package?

1=extremely difficult, 9=extremely easy

BiscTearStrip

1. How is it to grip the package?
2. How is it to open the package the first time?
3. How is it to take three biscuits from the package?
4. How is it to take the last biscuits?
5. What is your total appraisal of handling the package?

1=extremely difficult, 9=extremely easy
Appendix 4A

Appendices to the chapter 3.4.2.1 quantitative test A

Attributes developed and defined by the analytical sensory panel for the “user friendliness” of pots with screwing lids

Opening the first time

Package:
Grip ability  how easy is it to grip the jar or pot

Outer foil/strip:
Grip ability  how easy is it to grip the outer foil or strip
Power  how much power is needed to take away the outer foil/strip

Lid:
Grip ability  how easy is it to grip the lid
Power  how much power is needed to unscrew the lid

Inner foil/inner lid:
Grip ability  how easy is it to grip the inner foil or inner lid
Power  how much power is needed to take away the inner foil/inner lid

Required amount
First dose  how easy is it to take a specified amount of product out of the package

Closing of the package
Closure  how easy is it to close the jar or pot with the lid

Opening the second time
Power  how much power is needed to open the package the second time

Emptying the package
Emptying  how easy is it to empty the pot or jar completely

Total “user friendliness”
Total “user friendliness”  how easy is the package to handle considering all the attributes of “user friendliness”
1. How easy is it to open the package for the first time?

2. How easy is it to take out two tablets from the package?

3. How easy is it to close the package completely?

4. How easy is it to open the package the second time?

5. How easy is it to get out the last two tablets?

6. How easy is the package to handle considering all the attributes of “user friendliness”
Appendix 4B

Appendices to the chapter 3.4.2.2 Quantitative test B

1.1 Data Sheet - Personal information of test persons

<table>
<thead>
<tr>
<th>ID Code:_________</th>
<th>Test person’s name _______________________</th>
<th>Test person’s phone no. _____________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place of test: _____________________________</td>
<td>Date ______</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Male</td>
<td>Age ______</td>
</tr>
</tbody>
</table>

Do you often have difficulties opening packages: Yes | No
Are you familiar with the type of packages for test? Yes | No
Do you open food packages regularly? Every day | Weekly
| Monthly | Never |

<table>
<thead>
<tr>
<th>No disability</th>
<th>Disability</th>
<th>Diagnose of disability:__________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of disability: _______ years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of disability impacting hand: ________ years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have use of at least one hand? Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do you use eye wear for reading purposes?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you use eye wear during the test?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

| Are you left or right handed? | Right | Left |
## 1.2 Data Sheet - Strength measurements

ID Code:_____

### Grip Strength

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Strength (Kg force)</th>
<th>Trial #</th>
<th>Strength (Kg force)</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>1</td>
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</tr>
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<td>3</td>
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### Wrist Strength 70 mm

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</tr>
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<td>2</td>
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<tr>
<td>3</td>
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### Pinch Strength

#### Three fingered

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Strength (Kg force)</th>
<th>Trial #</th>
<th>Strength (Kg force)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
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#### Lateral

<table>
<thead>
<tr>
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<th>Trial #</th>
<th>Strength (Kg force)</th>
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<tr>
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<td></td>
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### Pinch Strength

#### Tip

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<td>2</td>
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### Thumb position and flexibility

#### Right Hand

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</tbody>
</table>

#### Left Hand

<table>
<thead>
<tr>
<th>Trial #</th>
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</thead>
<tbody>
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</tbody>
</table>

#### Positions of trouble, no. 0-10

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<th>Trial #</th>
<th>Positions of trouble, no. 0-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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A4/4
### 1.3 Data Sheet - Adult Test

ID Code:_____

<table>
<thead>
<tr>
<th>1. Packages name:</th>
<th>Time to open</th>
<th>Time over</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>5-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>1-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>2. Packages name:</th>
<th>Time to open</th>
<th>Time over</th>
<th>Comments</th>
</tr>
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<td>5-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>1-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Packages name:</th>
<th>Time to open</th>
<th>Time over</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>1-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Packages name:</th>
<th>Time to open</th>
<th>Time over</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>1-minute period</td>
<td>m</td>
<td>s</td>
<td></td>
</tr>
</tbody>
</table>
1.4 Data Sheet - Easiness of handling the packages

ID Code:______

7. What is it like to open the package for the first time?
   □ Extremely easy  □ Easy  □ Neither easy nor difficult  □ Difficult  □ Extremely difficult

8. What it is like to take the right dose/amount from the packaging?
   □ Extremely easy  □ Easy  □ Neither easy nor difficult  □ Difficult  □ Extremely difficult

9. What is it like to close the package?
   □ Extremely easy  □ Easy  □ Neither easy nor difficult  □ Difficult  □ Extremely difficult

10. What is it like to open the package for the second time?
    □ Extremely easy  □ Easy  □ Neither easy nor difficult  □ Difficult  □ Extremely difficult

11. What is it like to empty all the content from the package?
    □ Extremely easy  □ Easy  □ Neither easy nor difficult  □ Difficult  □ Extremely difficult

12. What is your overall judgment of the ease of opening the package?
    □ Extremely easy  □ Easy  □ Neither easy nor difficult  □ Difficult  □ Extremely difficult
2.1 Method - Grip strength procedure

The testing follows the standard testing position approved by American Society of Hand Therapists (ASHT).

The test person is sat down in a straight-backed chair with both feet on the floor and shoulder adducted and neutrally rotated. The elbow was flexed at 90°, the forearm was in a neutral position, and the wrist between 0-30° extensions. The arm was held in space rather than supported on an armrest or by the examiner. When assessing grip strength, the grip dynamometer was in the vertical position and in line with the forearm to maintain the position described above. The position of the dynamometer was located in the 2nd testing position. Everyone started the testing with the right hand, regardless of hand dominance. The test person held the squeeze maximally for 3 counts. The supervisor counted these 3 seconds by verbalizing: “Squeeze as hard as you can … harder, harder, stop”. While the right hand was allowed time to rest, the test person repeated the grip test with the left hand. This alternating sequence was being completed 2 additional times to make 3 trials on each side.

Equipment: Hand-held grip strength dynamometer (North Cost Medical, Precision Instruments, USA), see Picture 1.

Picture 1 Hand-held grip strength dynamometer.
2.2 Method - Wrist strength procedure

The sample with largest diameter is every time tested first; the medium sized sample the next and the sample with smallest diameter in the end of test. Sample diameter is 70mm.

The supervisor places the sample for test and makes sure that the equipment and sample does not rotate or move during the test. The test person is sitting down during the test and the equipment is placed in front of the person. The test person starts with the right hand. To begin with, the test person held the left hand on the table and grips the sample with their right hand. The test person is asked to turn the sample counter-clockwise to the greatest extent of their ability. The test person held the squeeze maximally for 3 counts. The supervisor counted these 3 seconds by verbalizing: “Turn as hard as you can … harder, harder, stop”. The reading is recorded and the equipment is zeroed. While the right hand was allowed time to rest, the test person repeated the wrist test with the left hand. This alternating sequence is being completed 2 additional times to make 3 trials on each side. The test is repeated for all 3 samples with both left and right hand.

Equipment: Bottle tester, TORNADO (JKM systems, DK), see Picture 2.

![Picture 2 Bottle Tester TORNADO](image-url)
2.3 Method – Pinch strength procedure: tip, key and palmar pinch

The testing follows the standard testing position approved by American Society of Hand Therapists (ASHT).

The test person is sat down in a straight-backed chair with both feet on the floor and shoulder adducted and neutrally rotated. The elbow was flexed at 90°, the forearm was in a neutral position. The arm was held in space rather than supported on an armrest or by the examiner. When assessing pinch strength, the pinch meter is always held by the supervisor at the distal end to prevent dropping. To measure tip pinch, the meter is grasped with the tips of thumb and index finger (Picture 3.T). To measure key pinch strength, the gauge is positioned between the pad of the thumb and the radial side of the index finger’s second phalanx (Picture 3.K). For palmar pinch strength, the gauge is grasped between the pads of the thumb, index finger and middle finger (Picture 3.P). The test person held the squeeze maximally for 3 counts. The supervisor counted these 3 seconds by verbalizing: “Squeeze as hard as you can … harder, harder, stop”. While the right hand was allowed time to rest, the test person repeated the grip test with the left hand. This alternating sequence was being completed 2 additional times to make 3 trials on each side.

Equipment: Hand-held pinch strength dynamometer (North Cost Medical, Precision Instruments, USA), see Picture 4.
2.4 Method - Thumb position and flexibility

The test person is asked to place the tip of the thumb in all the positions showed in the Picture 5. Start with position 0 and end with position 10. The supervisor fills in the results of the test (positions of difficulties without success) in the data sheet. The success criterion is when the thumb is in contact with skin in the described position. The test is repeated for both right and left hand.

*Picture 5. Thumb position test for position 0-10.*
4.1 Results – Strata

The aim of collecting test persons is fulfilled, according to the strata outlined (method section). Only an overweight of males appear in questions of “no disabilities” and “problems with packages” when considering the aimed consistance of 2/3 females and 1/3 males.

4.2 Results - Strength measurement

For the bar chart of distribution of the test population, the population is divided into intervals of strength in Newton force. Each interval shows the distribution of gender and incidence of disability specific for the interval. In order to make the bar chart visual comparable, the different total number between the groups: “disability, no disability, female, male” is converted into 100% in total for each group. One should be aware of, that the bar chart of the mean age distribution is connected to this bar chart showing the gender distribution of each strength interval. This is especially important when the frequency of a group is very low represented in an interval of strength. The percent of males representing the interval 63-74 Newton is 5% which is converted to only a single male. Due to this, the mean age is only calculated on the behalf of one test person, making the result less reliable.

The strength measurements include grip strength, pinch strength: 1) Tip pinch, 2) Key pinch, 3) Palmar pinch (three fingers) and wrist strength. Most of the measurements were carried out without problems, but some differences in performing the tests were observed. The wrist strength measurement was not adjusted according to the test persons height, making the test more force demanding to people of low height, even though, the test person was sitting down during the test. Difficulties were observed in controlling the test person’s position of finger during the pinch strength measurements of tip pinch and palmar pinch, resulting in lower comparability between test persons.
Pinch strength - lateral - right hand

Population %

25-37 38-49 50-62 63-74 75-99 100-

Newton

Disability
No disability
Female
Male

Pinch strength - lateral - right hand

Mean age

25-37 38-49 50-62 63-74 75-99 100-

Newton

Female
Male

Pinch strength - 3 fingers - right hand

Population %

0-19 20-39 40-59 60-79 80-

Newton

Disability
No disability
Female
Male

Pinch strength - 3 fingers - right hand

Mean age

0-19 20-39 40-59 60-79 80-

Newton

Female
Male
4.3 Results - Time keeping

The bar chart is divided into bars of 15 seconds intervals except for the bar chart of the coffee package, which has intervals of 30 seconds. The label “fail” refers to no success in opening of the package within the 5 minutes test period without instructions. One should be aware of the fact, that the number of packages tested for each package type is not identical.
4.4 Results - Score of easy opening

The results of the question “what is it like to open the package for the first time?” of the questionnaire experiment is shown in figures below. The score 1 refers to “very easy” and score 5 to “very difficult”.

Figure Bar chart of the results of the question “what is it like to open the package for the first time?” covering all eight packages where score 1 refers to “very easy” and score 5 to “very difficult”.

<table>
<thead>
<tr>
<th>No. of persons</th>
<th>score easy(1)-difficult(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
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<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

1. Mitt-Val
2. Ham
3. Milk
4. Tapini box
5. Can
6. Coffee
7. Cady
8. Biscuit
Appendix 4C

Appendices to the chapter 3.4.2.3 Quantitative test C

Testing procedure

The data was collected between 16 October and 5 November 2007 in Helsinki and Kangasala (rehabilitation centre Apila). Participants were recruited from the Finnish Rheumatic Association (patients and staff), from the rehabilitation centre (Apila), and from the Rheumatic Society of Helsinki (Helsingin Reumayhdistys). Only persons who felt that he/she have had difficulties in opening packages were included in the study. The aim was to recruit about 75-100 consumers in the age of 50-70 ± 5 years, approximately 70% females and 30% men.

The tests were carried out in the facilities of these institutes. Respondents were invited into a room, where they were given eight packages. Packages were labeled as K, L, M, R, S, T, V and X, and the order of presentation was randomized. Participants were asked to open the package, close it again, take a dose from the package and empty the package totally and evaluate the easiness of these operations. Participants were asked six questions per each package. They evaluated

1) how easy it was to open the package for the first time,
2) how easy it was to take a dose from the package,
3) how easy it was to close the package,
4) how easy it was to open it for the second time,
5) how easy it was to empty all content from the package, and
6) overall easiness of opening.

The ratings were given on scales ranging from 1 = extremely difficult to 9 = extremely easy. If the respondent was not able to open the package at all, the rating 0 was given in data processing. The Finnish questionnaire is attached as Appendix 1.

In addition, participants answered a series of questions about how they perceive their hand function, pain and ability to use various hand grip positions (Appendix 4C, 3.). Finally a few demographic questions were included (Appendix 4C, 2).

Demographic background of the respondents
Altogether 87 respondents participated in the study. As the target population for this study was elderly people with some problems in package handling, the majority of the respondents were between 46 and 75 years of age (Table 1). The mean age was 60 years. Most of the participants were female, and most of them lived either alone or with a spouse.
Table 1. Demographic characteristics of the respondents.

<table>
<thead>
<tr>
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<th>N</th>
<th>%</th>
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<tbody>
<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>male</td>
<td>17</td>
<td>19.5</td>
</tr>
<tr>
<td>female</td>
<td>70</td>
<td>80.5</td>
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<td><strong>Work situation</strong></td>
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<tr>
<td>Working</td>
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<td>Retired</td>
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<td>9.2</td>
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<td>36.7</td>
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<td>University degree</td>
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<td>33.3</td>
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<td><strong>Age group</strong></td>
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<td>30 – 45 years</td>
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<td>5.9</td>
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<td>46 – 55 years</td>
<td>25</td>
<td>29.4</td>
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<tr>
<td>56 – 65 years</td>
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<td>66 – 75 years</td>
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<tr>
<td>76 - 83 years</td>
<td>7</td>
<td>8.0</td>
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<td><strong>Number of persons in the household</strong></td>
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<td>42</td>
<td>48.3</td>
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<tr>
<td>3 or more</td>
<td>9</td>
<td>9.3</td>
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<tr>
<td>Total</td>
<td>87</td>
<td>100</td>
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</table>
Results

Hand function survey

Hand function and pain
About 32% of the participants indicated that they have hand dysfunction diagnosed by a doctor. Roughly 20 - 27% of the respondents considered their hand function as clearly bad (answer alternatives 1 – 5 included), but the majority (about 70%) considered it to be very or rather good (answer alternatives 7 – 9 included). More specifically, the respondents were asked to evaluate the strength, coordination, trembling and touch sensation of their right hand on the scale from 1 to 9, where 9 = normal function. Roughly 40% of the participants had at least minor problems with their hand (scores 7 or lower). However, 44% of the respondents evaluated their hand strength as “normal” (rating 9 on the scale), 49% indicated that their hand coordination is normal, and 56% that they have no trembling. Only 27%, 24% and 17% gave ratings of 6 than lower suggesting hand dysfunction, respectively. (Fig 1.)

Figure 1. Evaluation of functions of the right hand. Question 6. How would you describe your hand's physical strength, trembling, coordination and touch sensation? Shares of responses on the scale 1 – 9, where 9 = normal.

Hand function score was calculated as mean of three questions concerning the physical strength, coordination of the movement and trembling. (6a, 6b and 6c; attached questionnaire). The respondents were then classified into two groups based on the mean score, such that one third of respondents were classified as having lowered hand function (those with mean of 7.3 or lower) and two thirds as having nearly normal hand function (mean score 7.4 – 9). This cut-off point is artificial, but it illustrates the relation of hand function with perceived difficulties in package use. Questions about overall function of hands at the moment (question 9) and questions about physical strength and coordination (question 6) measured much the same thing. They correlated highly (r = .81 - .84).

About 53% and 59% of the respondents did not feel any pain in their right and left hand, respectively. About third of the respondents felt clear pain in their hands at the moment. Most of them felt the pain in their fingers and wrist (Fig. 2).
Figure 2. Location of the hand pain. Question 7b. Where you feel the strongest pain? Percentages of respondents who mentioned the part of the hand.

**Hand grip evaluations**

On the questionnaire, questions 12a – 12f were used to evaluate which kinds of grips were difficult for the respondents. The respondents were asked how well they think they can use the hand positions presented in figure 6 to take a grip. The answering scales ranged from 1 = I cannot use this grip to 5 = I can get a good grip.

![Grip positions](image1.png)

**Figure 3. Grip positions.**
The majority of the participants indicated that they are able to take a good grip with their right hand by using each of the grip positions (Fig. 4). About 20% had, however, at least small difficulties. Pen grip was perceived as the easiest one. Three respondents indicated that they are not able to take pinch and key-grips at all. As the right hand was presumably the better hand for most of the respondents, taking the grip positions with left hand was more difficult, as expected. Depending on the grip position, 32 – 38% indicated that they cannot take a good grip with their left hand (answer alternatives 1 – 4 included). (Fig. 4).

![Figure 4. Left and right hand grip positions. Question 12: Evaluate how well you are able to use these grip positions?](image)

Factor and correlation analysis suggest that if the person has difficulties in taking one of these grips he/she is likely to have difficulties in the other grips, too. Thus, the questions seem to measure much the same thing. When the right and left hand measures are included in the same factor analysis, two factors emerge: one for left and the other for right hand questions. Based on this result we calculated grip indices for right and left hand, respectively, as means of all six questions per hand. Thus, the grip index for right hand, for example, indicates how well the respondent thinks he/she can take these grips with the right hand.

The reliability (Cronbach Alpha) for the grip index concerning the right hand is 0.91, and 0.95 for the left hand index. The respondents were then classified into two groups according to their left hand grip index and according to their right hand grip index. The respondents with mean score of 5 were classified having good grip and the rest as having weaker grip.

Evaluation of the sample packages
The participants were asked to open the package and evaluate how easy it was to open, close and empty by using the scale from 1 = extremely difficult to 9 = extremely easy. Some of them did not manage to open some of the packages at all. In these cases their answer was recorded as 0 for the questions which related to opening (questions 1, 3, and 4) and as missing for other questions. This means that the results concerning closing, emptying and taking a dose from the package were only recorded from those who managed to open the package.

Results by package type
Coffee and candy packages used in this study were perceived clearly as the most difficult packages to handle, independent of the hand function of the respondent. This may be due to the specific features of the samples used in this study, and thus the result cannot be generalized to all coffee and candy packages. Handling of the tin package was also perceived difficult by a part of the respondents. In average, all other packages were estimated as being more easy than difficult to handle.
The pill jar was considered as relatively easy to handle, with the exception of opening (Fig 5). The best qualities of the ham package were re-opening and emptying. In contrast, closing was less easy (Fig 6).

In average, opening of these packages was not perceived as difficult. This was true to milk carton also, which was especially easy to re-open and take the contents out of it (Fig 7). The biscuit packages (the carton R and the laminate foil X) were the most easiest to open (Fig 8 and 12). These packages were rather easy to handle in other respects as well, except that it was not possible to re-close the tin foil (X). Closing was not possible for the tin either (Fig. 9). Coffee and candy packages stood out as the most difficult to handle; both opening and closing them was perceived as difficult (Fig 10 and 11).

Opening the candy bag was often difficult because the respondents did not always notice the opening cut at the top of the bag. In addition, when opened the entire bag sometimes fell open. This pack does not have any closure system, thus it was rated as difficult to close.

![Figure 5. Easiness of handling the pill package (K). Means and standard errors of mean. (Note that 2 respondents did not manage to open the package and thus they have not evaluated closing, taking a dose or emptying the pack.)(K)](image)

![Figure 6. Easiness of handling the ham package (L). Means and standard errors of mean.](image)
Overall judgement of the ease of opening.

Figure 7. Easiness of handling the milk package. Means and standard errors of mean.

Figure 8. Easiness of handling the Tapini package. Means and standard errors of mean. (Note that 1 respondent did not manage to open the package and thus he/she has not evaluated closing, taking a dose or emptying the pack.)

Figure 9. Easiness of handling the tin. Means and standard errors of mean.
Figure 10. Easiness of handling the coffee package. Means and standard errors of mean. (Note that 27 respondents did not manage to open the package and thus they have not evaluated closing, taking a dose or emptying the pack.)

Figure 11. Easiness of handling the candy package. Means and standard errors of mean. (Note that 14 respondents did not manage to open the package and thus they have not evaluated closing, taking a dose or emptying the pack.)

Figure 12. Easiness of handling the biscuit package. Means and standard errors of mean.
**Influence of hand function and differences between the package types**

We compared respondents with difficulties in their hand function with respondents with virtually normal hand function. As could be expected, participants with more hand function problems perceived more difficulties in handling the packages. Respondents’ own estimation of their *ability to use different right hand grip types* (question 12) was clearly related to the perceived easiness of opening the packages. Especially, opening of the tin, ham, candy and milk packages was perceived as more difficult by those with weaker ability to take grips with the right hand (Fig. 13). On the other hand, opening the coffee and candy packages were perceived difficult by almost all participants irrespective of the hand function (Fig. 14). Opening of package of biscuits was relatively easy for all. Also the measures of the ability to take left hand grips and the measures of hand function (question 6) were related to the easiness of opening, but the relations were less clear than those of opening the package for the first time with the right hand.

![Figure 13. Right hand grip and easiness of opening the sample packages for the first time. Good hand grip (grip index=5), weaker hand grip (grip index=1-4). Means and standard errors of mean.](image)

![Figure 14. Percentages of respondents who perceived difficulties in opening the package by their right hand grip ability.](image)

Respondents’ evaluations of their pain experience in left and right hands (questions 7.) were correlated with evaluations of easiness of package handling (Appendix 4; Fig. 15). These correlations suggest that the pain in the left hand impedes especially taking a dose from the package and emptying it in those cases, where the package cannot be emptied with one hand. The pain experienced in the right hand seems to influence package handling less.
In general, respondents with more deficiencies in their hand function experienced more difficulties with all package types than those with normal hand function ($F(1)=9.06; \ p=0.004$). Respondents with deficiencies in hand function seemed to have more difficulties in opening especially the tin, but also the milk and ham packages, compared to those with better hand function.

Figure 15. Easiness of taking the right dose from the packages in respondents who experience pain in their left hand ($n=26$) and who don’t ($n=59$).
Questionnaire for the evaluation of packages in quantitative test C

1. What is it like to open the package for the first time?
   - Extremely difficult
   - Very difficult
   - Difficult
   - Fairly difficult
   - Neither difficult nor easy
   - Fairly easy
   - Easy
   - Very easy
   - Extremely easy

2. What it is like to take the right dose/ amount from the packaging?
   - Extremely difficult
   - Very difficult
   - Difficult
   - Fairly difficult
   - Neither difficult nor easy
   - Fairly easy
   - Easy
   - Very easy
   - Extremely easy

3. What is it like to close the package?
   - Extremely difficult
   - Very difficult
   - Difficult
   - Fairly difficult
   - Neither difficult nor easy
   - Fairly easy
   - Easy
   - Very easy
   - Extremely easy

4. What is it like to open the package for the second time?
   - Extremely difficult
   - Very difficult
   - Difficult
   - Fairly difficult
   - Neither difficult nor easy
   - Fairly easy
   - Easy
   - Very easy
   - Extremely easy

5. What is it like to empty all the content from the package?
   - Extremely difficult
   - Very difficult
   - Difficult
   - Fairly difficult
   - Neither difficult nor easy
   - Fairly easy
   - Easy
   - Very easy
   - Extremely easy

6. What is your overall judgement of the ease of opening the package?
   - Extremely difficult
   - Very difficult
   - Difficult
   - Fairly difficult
   - Neither difficult nor easy
   - Fairly easy
   - Easy
   - Very easy
   - Extremely easy
Date, interviewer: ………………………………………

Interview location: ………………………………………

Questionnaire on demographic background information of the respondents

1. Gender
   □ Male
   □ Female

2. Year of birth ________________

3. What is your working status?
   □ In full-time employment
   □ In part-time employment
   □ Unemployed or no professional activity
   □ Retired

4. What is your highest qualification?
   □ Secondary school graduate
   □ High school graduate
   □ College degree
   □ Academic or university degree

5. How many people are there living in the same household with you (including yourself)? __
Hand function survey
Questions about you and your hand function

6. How do you experience your hand function?
   a Physical strength
      None       Normal
      □          □
   b Coordination of the movement
      Clumpy       Handy
      □          □
   c Balance
      Trembling       Balanced
      □          □
   d Perception of touch
      No perception of touch       Normal
      □          □

7. Do you feel pain in your hands at the moment?
   Right hand
      Extreme pain       No pain
      □          □
   Left hand
      Extreme pain       No pain
      □          □

Where do you feel the pain in your hands as strongest?…………………………………………

8. Do you have a hand dysfunction diagnosed by a doctor?
   □ No
   □ Yes, what diagnose, and when did you get it? …………………………………………………

Describe the difficulties in your hand function………………………………………………...

9. How is your hand function at the moment?
   □ Very bad       Very good
     □          □

10. How do you experience the difference in function between you right hand and your left hand?
    □ Major difference       No difference
      □          □

11. How is the pain during the day?
   □ Continuous
   □ Coming and going
         □          □

Other …………………………………………………………………………...
Screening the grips of hands

12. How do you evaluate you can use the following grips?

Left hand

I can not get a tight grip   I can get a tight grip

Right hand

I can not get a tight grip   I can get a tight grip

a. Key pinch grip

b. Key grip

c. Chuck grip (Pencil grip)

d. Five finger grip

e. Diagonal volar grip

f. Transversal volar grip
Correlations between easiness of handling the packages and evaluated hand pain

Easiness of handling the packages correlated with evaluated pain in the left and right hands.

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<th>PAIN Left</th>
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</table>
Nordic Innovation Centre

The Nordic Innovation Centre initiates and finances activities that enhance innovation collaboration and develop and maintain a smoothly functioning market in the Nordic region.

The Centre works primarily with small and medium-sized companies (SMEs) in the Nordic countries. Other important partners are those most closely involved with innovation and market surveillance, such as industrial organisations and interest groups, research institutions and public authorities.

The Nordic Innovation Centre is an institution under the Nordic Council of Ministers. Its secretariat is in Oslo.

For more information: www.nordicinnovation.net

NORDTEST

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