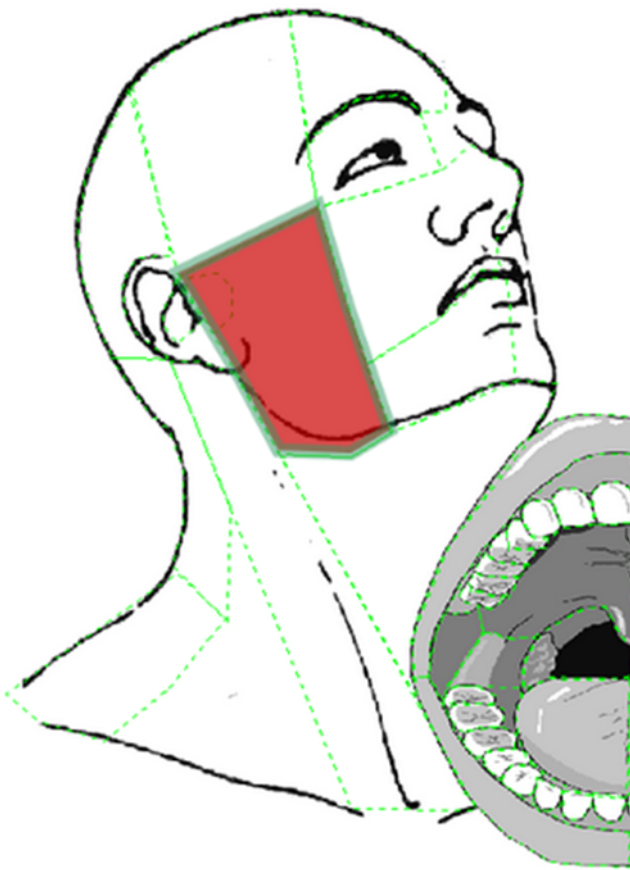# Exploring the Landscape of WISE

Improving the Usability of a complex Medical System

Master's Thesis

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Abstract

The goal of this thesis was to improve the usability of a Web-based Interdisciplinary Symptom Evaluation system (WISE) which has been developed and used by the orofacial pain clinic of the University of Zurich. WISE, as its name suggests, is a web-based tool, that captures and assess the interdisciplinary complaints of patients who suffer from orofacial pain.

The underlying difficulty in improving the system was that with anonymity of health care patients, we couldn't get personal feedback from the main user group. We used two different approaches to evaluate the underlying survey concept and reveal possible problem areas. The first approach was the well-established approach of evaluating the existing user feedback. We then developed a hands-on approach to create a paper-based survey logic diagram. This has proven especially helpful to analyse this large and complex questionnaire.

We found that the length and complexity was the biggest weakness of the old WISE survey. To address these problems, we reorganized the survey structure, eliminated superfluous questions, simplified the survey vocabulary, and updated the welcome page of the survey. We also corrected flaws in the survey logic and included more open-ended questions such that patients would be able to describe their problems in their own words. We addressed usability problems of certain question types through prototyping and user testing.

The main contribution of this thesis includes all improvements that were made to the WISE survey. The description of the approach to create a paper-based survey logic diagram is an additional contribution of this work.

Acknowledgements

I specially thank Beat Steiger and Dominik Ettlin who entrusted me with the improvement of their WISE system and supported me throughout this thesis.

I also want to thank my advisor Prof. Chat Wacharamonotham for all the good suggestions and plenty of interesting reading material. All his patience and experience helped me a lot.

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Chapter 1

Introduction

This master thesis aims to improve the usability of the WISE system that was developed and used by the *Orofacial Pain Center* of the University of Zurich. The first Section of this Chapter explains what WISE stands for and why it was created in the first place. In the second part of the Chapter we shed light on the concrete problem formulation that lead to this thesis.

1.1 About WISE

The term *WISE* is an acronym and stands for *Web-based Interdisciplinary Symptom Evaluation* (we will explain he meaning of these words in the next paragraphs). WISE is an online tool which was developed by the orofacial pain center of the University of Zurich [Ettlin et al., 2016].

The tool was built to digitally collect physical and psychosocial information from patients that seek consultation from the orofacial pain center. Patients consult the orofacial pain clinic for different reasons. Most treated complaints that are associated with some kind of orofacial pain, or a temporomandibular disorder. *Orofacial pain* is a collective term which refers to any pain felt on the face or head, in the mouth, or at the jaws [Nixdorf et al., 2012, Okeson, 2008]. *Temporomandibular disorder* is a term for any complaint that is related with movements of the jaw. *Temporomandibular* thereby refers to the area

around the jaw joint [Okeson, 2008, Staff, 2018].

Many of the patients that are referred to the orofacial pain clinic do suffer from chronic pain. A lot of research has shown the that chronic pain and psychosocial problems are correlate with each other. Therefore, treatments with a comprehensive approach, that take both chronic pain and psychosocial issues into account, can have big impact on the patients well-being [Eccleston, 2001]. This interrelation between physical and psychosocial factors is also observable for patients that suffer from orofacial pain or temporomandibular disorders [Dworkin et al., 2002, Dougall et al., 2012].

WISE (Web-based Interdisciplinary Symptom Evaluation) therefore stands for a web-based tool, which was built to capture and assess the symptoms of interdisciplinary complaints (including physical and psychosocial parameters).

1.2   Problem Description

The WISE system is currently used by the orofacial pain unit of the University of Zurich. Since the launch of WISE in 2017 the clinic got many good reviews of their tool and several other dental clinic showed their interest for the tool. This is why they now plan to offer WISE as a service for other clinics. As a part of this project, this thesis aims to improve the WISE system from a usability perspective.

Two components of WISE are especially interesting to explore: The *WISE Survey* through which patient have to record their complaints, and the *Patient Summary Report* that physicians use to interpret the entered data.

1.2.1   WISE Survey

The user-friendliness of the WISE survey is important, because for many patients this survey will be the first interaction that they have with the clinic. The quality of the survey will therefore influence the assessment of the professionalism of the clinic itself.

Improvements in the WISE survey potentially benefit a large number

patients which will have to fill out the survey in the future.

1.2.2 Patient Summary Report

The other component that arouse our interest is the patient summary report. This report summarizes the survey answers from a patient into a manageable overview. Dental doctors, psychologists, and clinic assistants would access these reports on a daily basis. Exploring what information are important for which user group and re-designing the patient report accordingly, could support the clinic employees in their daily tasks.

Unfortunately, we did not have enough time to address both problem areas. This thesis therefore focuses mainly on the evaluation and improvement of the WISE survey.

Chapter 2

Related Work

In this Chapter we first give a short introduction to related medical topics and then describe the HCI (Human-Computer Interaction) approaches that were used within this thesis.

2.1 Related Medical Work

This section is meant to give a short overview of important medical terms and concepts that are used within this thesis.

2.1.1 Orofacial Pain & Temporomandibular Disorders

Orofacial pain is a collective term which refers to any pain felt on the face or head, in the mouth, or at the jaws [Nixdorf et al., 2012, Okeson, 2008]. One of the main causes of orofacial pain are dental problems that are related to an inflammation of the inner tissue of the teeth which separates the tooth nerves form the teeth itself, or to a dental abscess. Temporomandibular disorders are another common cause for orofacial pain [contributors, 2019a].

Temporomandibular disorders include any complaints that are related to the movement of the jaw. Temporomandibular thereby refers to the are around the jaw joint, which is usually the are that is affected by temporomandibular disorders. Okeson [2008], Staff [2018]

2.1.2   Chronic Pain & Interdisciplinary Symptom Evaluation of Orofacial Pain

Pain is classified as chronic when patients suffer from continuing or reappearing pain during a time frame from 3 to 6 months. This means that the pain continues longer than the natural healing time. Chronic pain can occur together with various types of diseases or afflictions that cause pain. [Treede et al., 2015]

Modern research has found a correlation between the suffering of chronic pain and mental disorders. They found that people that suffered from chronic pain often also had some kind of mental problems. It is not yet clear whether one of the two factors fosters the other, but when treating chronic pain it is very important to also consider possible psychological disorders. Taking such a comprehensive approach to the treatment of chronic pain patients can have a big impact on the patients well-being. [Eccleston, 2001, Flor et al., 1990]

This interrelation between physical and psychosocial factors was also observed for patients that suffered from temporomandibular disorders or other kinds of orofacial pain. This is the reason why many physicians propose to include criteria of both, physical symptoms as well as psychological conditions, into the diagnosis of orofacial pain causes and possible treatments. [Dworkin et al., 2002, Dougall et al., 2012]

2.2   HCI Approaches

This section gives a short introduction to different HCI techniques that were used within this thesis.

2.2.1   Affinity Diagrams

An affinity diagram is a very easy and intuitive way to structure and analyse a large amount of unstructured information. The creation of an affinity diagram includes two main steps. First all information snippets need to be recorded on sticky notes. Each sticky note should only contain one idea or key concept. In the second step the created

sticky notes are organized into groups and a label is assigned to each of the groups. [Holtzblatt et al., 2004, Pernice, 2018]

The technique is very simple and time effective. Affinity diagrams can be created by individuals as well as with teams. The main drawback of affinity diagrams is that they are usually non-transportable and need to be captured through picture to share. [Holtzblatt et al., 2004]

2.2.2 Card Sorting

Card Sorting is a technique that was developed by Donna Spencer to organize information effectively. The techniques main goal is not to find the one perfect way to organize information, but to get insight about the people that will have to work with this information. It is an approach to determine whether people have similar views on how to organize information or whether people use different classification schemes to do so. [Spencer, 2009]

The technique can be used for different types of projects that involve information architecture. Practical examples include the structuring of a new website, the organization of an internal wiki-page, or what filter options to include in a search option. The results form a card sort can be a list of categories used for classification of data, labels for group names, understanding how people understand the data, and which information are easy to categorize, and which are not. [Spencer, 2009]

The underlying idea of the *Card Sorting* technique is simple. Create a card for every item or information that you want to organize. Each card has a label that describes the item or information that the card represents. Give the cards to the users that work with the information and let them sort the cards into different groups. Record and analyse the results and you will have a better understanding of your users and their thoughts about the information that they have to work with. [Spencer, 2009]

Spencer distinguishes between two different *Card Sorting* approaches. You can either do an open card sort where the users can create their own categories, or you can do a closed card sort with predetermined categories. The closed card sort is less informative than the open card sort, because the fixed categories exclude insights about other organization schemes. If possible, use the open card sort approach. Only

perform a closed card sort, when you are not able to change the categories, when you want to add new information to an existing information structure, or when you are very confident of the groups that you have. [Spencer, 2009]

While the technique holds many benefits and can reveal very interesting ways of thoughts of the users, it also has some limitations. Spencer stresses out that Card Sorting should never be used on its own and without critical reflection. The result of the card sort needs to be placed into the context of its actual use. Any other information that is available and your common sense should be included in the final organization and naming of the groups. Complementary strategies are to include interviews, surveys, as well as the analysis of any other information that is available. [Spencer, 2009]

2.2.3   Human-Centered Design Process

The human-centred design process is a tool to ensure that developed software meets the needs of its end users. The technique includes a sequence of 4 steps which are repeated as many times as needed. [Norman, 2013]

The steps of the human-centred design process are the following: [Norman, 2013]

- *Observation*: observe and explore the nature of the problems
- *Idea Generation*: generate ideas to solve the detected problems
- *Prototyping*: make the ideas tangible by prototyping
- *Testing*: test the prototypes of your solution with real users

These steps are then repeated until a good solution is found and no more problems occurred. Through the iterative process, rapid prototyping and testing should be allowed. The advantage of this technique is that it includes the end user in the developments process of a product and the resulting product was built with the user in focus. [Norman, 2013]

2.2.4   Persona

A *Persona* is a graphical representation (including text and images) of the needs, thoughts, and intentions of a person. The technique was originally introduced by Cooper et al. [2004] in a chapter of their book *The Inmates Are Running the Asylum*. Since then, HCI researcher (among others) have used the concept of personas, developed it further and investigated its effects. [Chang et al., 2008]

Personas can visualize and describe the needs and goals of the end user in a very intuitive way. Having such a persona at hand, when designing a new product helps to empathise how the end users would work with it. This way the focus of software that is designed lies on the user and his needs. Another way to use personas, it to communicate ideas and problems with other involved stakeholders. Having a mutual understanding of the end user, facilitates the discussion of design ideas and solutions. [Chang et al., 2008]

2.2.5   Sequence Modelling

A sequence model (as described in the book *Rapid Contextual Design:* by Karen Holtzblatt) can be used to visualize the different activities that people need to perform or complete a task. The sequence of a model first captures the intent of an action. The second item is the trigger event or condition, that provoked that the user would start to take actions. And the third component includes all the steps that need to be performed to finish the task. [Holtzblatt et al., 2004]

The completed sequence model then gives an overview of all the actions that are involved to accomplish a task as well as the underlying motivations and action triggering situations. Understanding how people work is an important step to understand possible problem areas and develop tools that support and not obstruct the users in their work. [Holtzblatt et al., 2004]

2.2.6   Writing for easy Reading

Reading is a skill that we start training at a young age. It is a skill, we use almost every day, but the ability to read doesn't come to us

naturally. It requires rigorous training of our visual system to recognize lines and shapes, form them into letters and words, and combine the words to understand the meaning of a phrase. Skilled readers will be able to recognize word patterns rather than having to read single letters or words. In addition to the pattern recognition, the brain also needs to learn how to move the eyes correctly. The eyes are only able to clearly see 3-4 characters and a total of 15-20 can be recognized at once, even if the image is not very clear. To read a line of text the eye therefore must jump several times. To read a whole paragraph, we will scan every line of text. Our eyes thereby skip the fixation on the last words of the line and jump back to the left border of the text, one line below. [Johnson, 2013]

Eye-tracking researchers have found that people read an online text in an F-shaped pattern. The attention and visual activity are usually the strongest in the upper left part of the page and becomes weaker towards the bottom of the page and the right side edge of the page. They also found that users don't read the complete page of a website to find the best possible action to perform. Users only read until they feel that they know enough to make a decision about the next action. In addition, people will skim most of the page for relevant keywords or phrases, and only read the first 1-2 lines properly. Eye-tracking studies also found that people would rather read bullet lists than large blocks of text. [Lior, 2013]

Because of these findings the following guidelines need to be considered to ensure a good reading experience:

- Avoid uncommon vocabulary [Johnson, 2013] [Lior, 2013]
- Don't use fancy fonts or ALL CAPS for text [Johnson, 2013]
- Avoid images as background behind text and make sure that the text has a good contrast to the background [Johnson, 2013]
- Don't use centered design for large texts [Johnson, 2013]
- Reduce the amount of text whenever possible [Johnson, 2013] [Lior, 2013]
- Put the most important information at the top of the page [Lior, 2013]
- Use bullet lists instead of long paragraphs [Lior, 2013]
- Include keywords in the text for which the user will probably search [Lior, 2013]
- Facilitate scanning by placing the most important information at the beginning of the text [Lior, 2013]
- Structure the content of the page into meaningful pieces of in-

formation [Lior, 2013]

- Place text and related objects of images close to each other to make it clear that they belong together [Lior, 2013]

Chapter 3

Understanding WISE

WISE (Web-based Interdisciplinary Symptom Evaluation) is a web-based tool, which was built to capture and assess the symptoms and interdisciplinary complaints of patient which suffer from an orofacial problem.

Before we start to investigate how the WISE survey can be improved, it is important to understand the context and ecosystem for which this survey was created.

In the next sections, we will first explain why WISE was created (see Section 3.1). Then we will explain the different components of WISE (see Section 3.2 and how the system is used on a daily basis (see Section 3.3).

3.1   Purpose of WISE

WISE was initially developed as a tool that could support and simplify the medical assessment of the patients and their complaint. With an online questionnaire, aspects that would commonly be assessed with questionnaires or check lists, could be condensed into one large digital evaluation. The WISE questionnaire was implemented with LimeSurvey which allowed to define logical conditions for the display of a question. In this way users would only see questions that are relevant for their medical case. [Ettlin et al., 2016]

A large benefit of the digital form of the questionnaire is that both sides, the physicians of the clinic as well as the patients, can save a lot of time. The physicians save time, because they do no longer have to manually evaluate and record the findings from the paper surveys and check lists. And the patients save time, because they can fill out the survey whenever and wherever they want and do not have to travel to the clinic to fill it out. [Ettlin et al., 2016]

Moreover, the online survey is also more cost-effective than its paper counterpart. The comprehensive approach of the survey content, allows that filling out the WISE survey could (partially) replace the initial appointment with the doctor. The team of the orofacial pain center of the University of Zurich includes dental specialists as well as pain psychologists, which is a special characteristic of their clinic. Through the pre-evaluation of the complaints of the patient, they are able to determine whether the patient only needs an appointment with a dentist or if a double-appointment with a pain psychologist is needed. Knowing this beforehand allows that double-appointments can be scheduled close together on the same day. This saves the patient travel time and effort to visit the clinic. [Ettlin et al., 2016]

As a last benefit, consistently assessing the complaints of the patients of the orofacial pain center through the WISE survey, expands the possibilities to conduct research. [Ettlin et al., 2016]

3.2   WISE Components

WISE consists of three main components that are interconnected: the *WISE System*, the *WISE Survey* that runs on *LimeSurvey*, and the mySQL database that is linked to LimeSuvey. In addition, an *Access Database* is used as a fourth clinic specific part.

3.2.1   WISE System

The WISE System is the core of WISE and it was built as a web-application. Physicians, assistants, and secretaries of the clinic can login to the WISE system, administrate their patients, trigger new surveys for their patients, and access the *Patient Summary Reports* of already filled out surveys. Every patient that is registered in the WISE

Figure 3.1: The *Patient Summary Report* displays the answers of a patient that has completed the WISE survey.

system has a unique identification number (patient ID), apart from this, no other identifying information (e.g. names, or the day of birth) are stored.
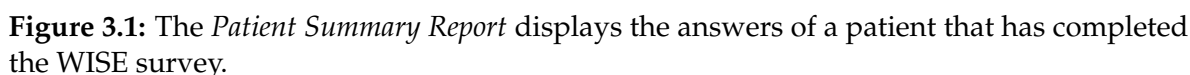
When a new patient is referred to the clinic, the WISE system will generate the login credentials and the invitation letter to the survey. Additionally, the system will generate a unique token which is also added to the LimeSurvey. This token then links the patient information from the WISE system with the data entered into LimeSurvey and its corresponding mySql database.

The practitioner of the clinic can access the answers of a completed surveys by searching for the patient ID and opening the linked *Patient Summary Report*. The patient summary report gets the data from the LimeSurvey database and displays it in a summarized form on the WISE System (see Figure 3.1).

Patients that received the invitation letter can login to the WISE system. From there they will be forwarded to the LimeSurvey page on which they can fill out the questionnaire. After completing the WISE survey, the patients will be able to access their patient summary report on the WISE system.

3.2.2   LimeSurvey & MySql Database

LimeSurvey is an open source software to create and manage online surveys. To install and host LimeSurvey on your own servers, you also need database on which the answers of the participants will be saved. The orofacial pain center used a mySQL database to do so.

The WISE survey was created and administered with the LimeSurvey software.

3.2.3   Access Database

The orofacial pain center uses an access database to store identifying information of their patients (e.g. patient name and birthday). Through the unique patient ID, that is stored in the access database as well as on the WISE system, the identifying user information are linked with the anonymous information on the WISE system. The access database is configured in such a way that a button directly opens the data of the selected patient, on the WISE system. This configuration offers a quick access to the summary reports of a patient. The WISE system itself has no link back to the access database of the clinic.

WISE doesn't need the access database to link the user data together. As long as the patient information is stored together with the unique patient ID, any type of data recording tool can serve this purpose - even an excel sheet.

3.3   WISE Usage

WISE has many usages in the daily routine of the orofacial pain center of the University of Zurich. The different usages that are described below were gathered from different conversations with the practitioners of the orofacial pain center.

Register new Patients.   When a new patient is referred to the clinic, one of the first things that must be done, is to register the new patient

into the WISE system. We drew a sequence model to visualize the exact process of how this registration is done (see Figure 3.2).

To understand the different steps of the registration process, read the diagram column by column starting on the left. The actor for each step is written at the top of every column. The blue items represent steps that are unique to the orofacial pain unit of the University of Zurich and the black items describe the steps that any clinic who uses WISE would need to perform.

The first registration step is to add patient information. This step includes the creation of a new user in the WISE system. Triggered by a new entry, the WISE system would then create the token that connects the patient data of the WISE system to LimeSurvey, as well as the patient login credentials for the WISE system. After that the clinic secretaries would then send out the survey invitation letter with the login credentials to the patient. The patient can then log into the WISE system and from there be forwarded to the WISE survey located on LimeSurvey. The registration is completed as soon as the patient submits the finished WISE survey.

Schedule Appointments.   In a second step the patient information from the WISE survey will be used to plan and schedule an appointment with the patient. The corresponding steps are included in the diagram of Figure 3.3.

The point to consider in this step, is whether the patient will get a single appointment with one of the dentists or whether a double appointment including one session with a pain psychologist is needed. To decide this, the person in charge inspects the patient summary report (see Figure **3.1**). As a rule of thumb, we learned that the more red items (e.g. pain drawings, or critical scores displayed on the right edge) were included in the report, the more likely a double appointment would be scheduled.

Prepare Appointment.   The patient summary report of WISE would also be used by the physicians to prepare themselves for the first appoint with the patient (see last column of Figure 3.3). We found that a print-out of the patient report was included in every (physical) patient chart.
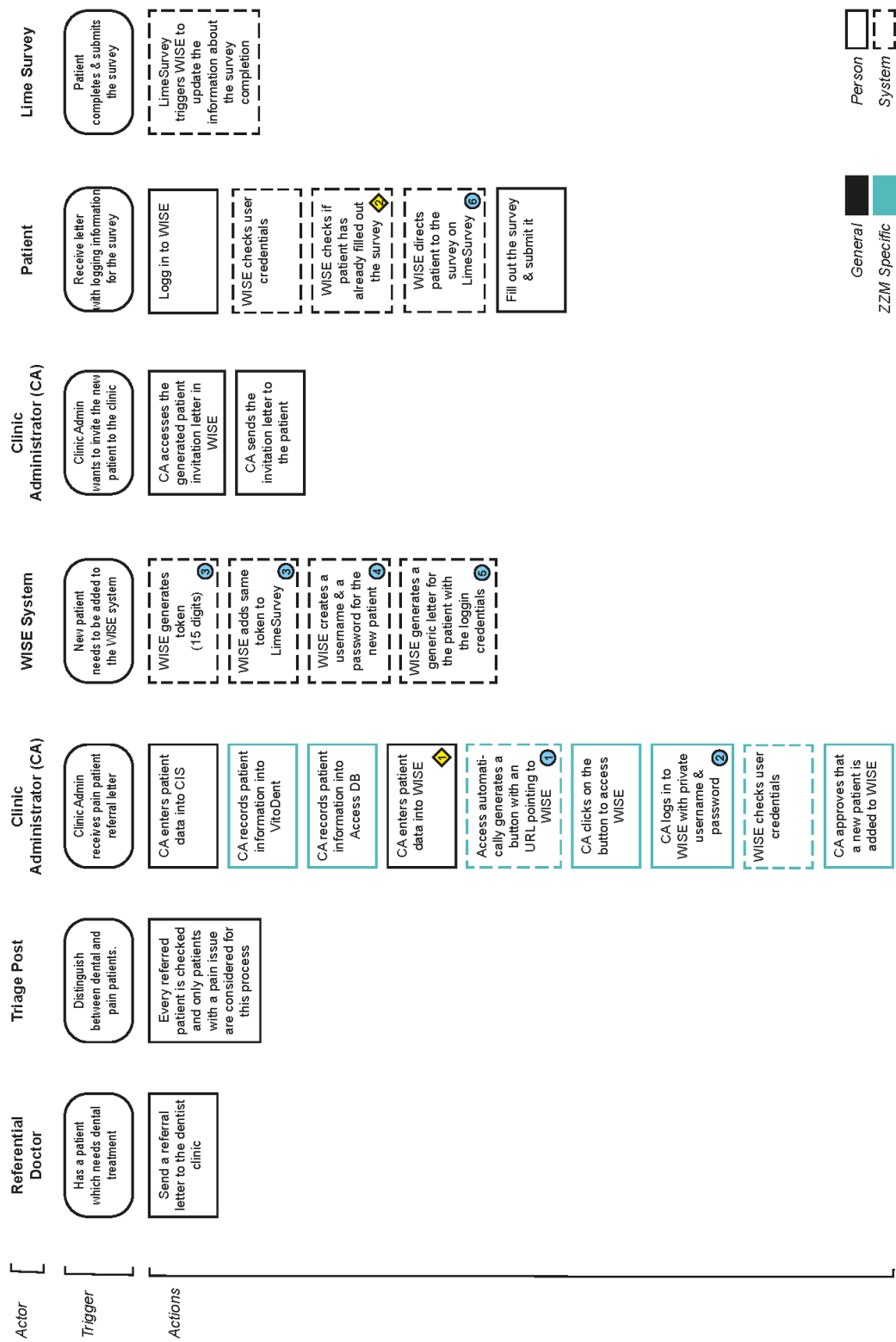
Figure 3.2: This model described all the steps that are performed when a new patient is referred to the clinic.

Actor	CRON	Team Member (TM)	Clinic Administrator (CA)	Clinician
Trigger	Every day at a pre-specified time	Receive notification email about new survey submissions	Receive notification with appointment decision	Learns about new patient assignment
Actions	Checks WISE for new survey entries	TM looks at the survey summaries of the new patients	Schedule appointment(s) in VitoDent	Look up patients ID in the CIS
	Sends mail with a summary of the new entries to the CM	TM records survey return information into Access DB		Look up the patient ID in the access DB
		TM schedules an appointment for the patient		Click on the button that opens the patients WISE page
		Decide if the patient only needs an appointment with the dentist or also with the psychologist		Logg in to WISE
		TM forwards notification with decision to CA		Look at the summary report of the patient ⑦

Figure 3.3: In this model the steps to schedule and prepare a patient appointment are described.

Communication Support.   We also found that the patient summary report was an important communication aid. In the weekly clinic meetings, the summary reports of the patients were often shown with a projector, to exchange information about a specific case and discuss possible treatment approaches.

We also saw that the summary report is sometimes used during the appointment with the patient. Physicians would for example refer to the answers of a special question and later inquire more about it. Or the pain drawings could be used to explain the relation between different body parts and the complaint that the patient was suffering from.

Chapter 4

Understanding the Problems of the WISE Survey

To develop solutions that would improve the usability of the WISE survey, we first needed to determine the problem areas that we wanted to focus on. We used existing user feedback about the survey as a starting point for our investigations. During the same time period we also started to get ourselves familiar with the content of the WISE survey. To understand the interconnections between the different survey parts, we created a paper-based diagram that visualized the logical connections within the survey.

The results and implications of the user feedback evaluation are discussed in Section 4.1.4. The technique that we used to create the survey logic diagram is described in Section 4.2.1. The detected problems from the survey logic investigation and their impact on the steps needed to find a solution are described in Section 4.2.2.

4.1   User Feedback Evaluation

The original WISE survey included some optional feedback questions at the end. Every patient of the Orofacial Pain Unit who filled out the WISE survey, was asked at the end whether or not he/she wanted to give additional feedback on the survey.

This user feedback was the starting point to investigate possible problems and room for improvement. We decided to look at all answers that were given within the first two years since the launch of the online survey. The investigation period was restricted to two years, because the physicians of the orofacial pain unit wanted to perhaps publish the results in a paper. The time interval of two years could later be used as reference interval for newer WISE versions.

In the next sections the content of the user feedback (Section 4.1.1) and the results from the closed and open question analysis (Section 4.1.2-4.1.3) are presented. As a conclusion, the implications of these findings are discussed in Section 4.1.4.

4.1.1   Content of the User Feedback

The WISE survey included both closed-ended and open-ended feedback questions.

Most of the questions in the survey were closed questions asking about the usability of specific parts of the survey. The closed questions inquired about the quality and usage of the following topics:

- Invitation letter and login
- Initial (welcome) page of the WISE survey
- Video instructions
- "Pain Drawing" question
- "Daily Pain Course" question
- "Medication Entry" question
- Whether or not they would recommend the survey to another institution

The open-ended question question then inquired deeper on the following issues:

- Reasons for not recommending the survey
- Missing topics that were not asked

4.1.2 Closed Questions Evaluation

The closed ended questions are analysed in a descriptive way using diagrams to illustrate the findings.

Most of the feedback questions were filled out exclusively by the people who had agreed to answer them. A bug in the survey logic caused that some questions were also shown to participants that didn't want to answer them. This mistake was corrected later. The number of answer (N) will be indicated for each question separately to account for this dissimilarity.

During the period of two years (from 15.03.2017 - 14.03.2019) 1065 patients have filled out the WISE survey. About 80% (861 answers) of the participants, stated that their answers could be used for research purposes, which allowed us to investigate their feedback further.

From the 861 participants who shared their answers with the researchers, 320 (37.2%) were willing to give feedback on the survey. 370 (43.0%) people stated that they hadn't encountered any difficulties and therefore there was no need to give additional feedback. In contrast, almost every 5th (19.9%) encountered problems, but they refused to answer further questions. This might be a first indication that there might be some room for improvement.

Invitation Letter & Login

New patients of the orofacial pain unit are asked to fill out a survey before they obtain an appointment with the physicians. Patients receive the invitation letter to this survey in a postal letter.

The letter first informs the patient that he/she was referred to the clinic specialized in chewing function disorders. The patient then is asked to fill out the survey by using the provided url and login credentials (username + password). Next comes information on the content of the survey and data protection. At the end, patients are informed that they will receive a consultation appointment after the completion of the survey. On a supplementary sheet, the course of treatment at the clinic is explained.
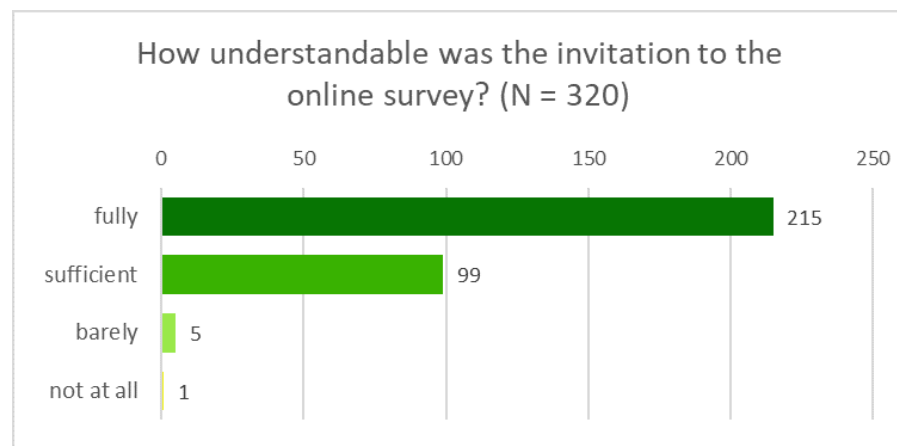
Figure 4.1: 98% of the people found that they understood the invitation letter sufficiently or fully.

Invitation Letter.   Users were asked how well they understood the invitation letter that they received per post.

The majority (67%) of the answers stated that the invitation letter was *fully understandable* and another 31% rated the invitation as *sufficiently* understandable. Less than 2% of the answers said that the invitation was *barely* or *not at all* understandable (see Figure 4.1).

The invitation letter therefore seems to be well-written and comprehensible.

Login Attempts.   In this question the participants were asked how many attempts they had used to login to the web-page and fill-out the survey.

Most of the people (62%), that had answered this question, used only *one attempt* to login to the survey. Every fifth person needed *two* attempts to login, and every sixth person used *three* (8%) or *(four and) more* (8%) attempts (see Figure 4.2).
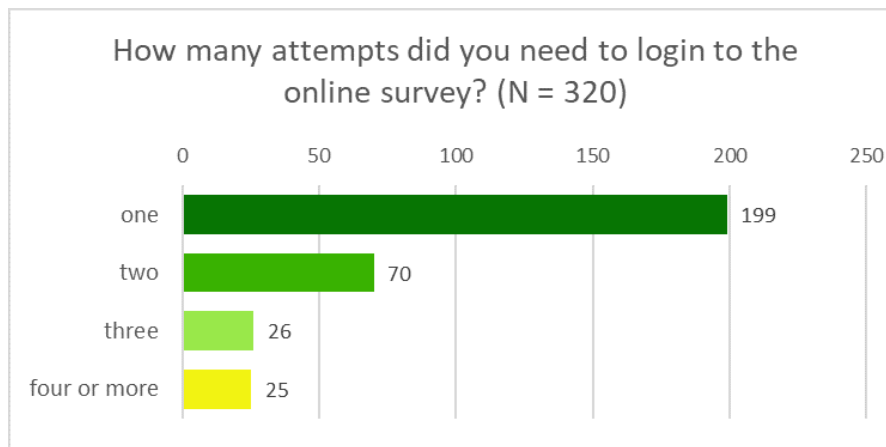
Figure 4.2: Every sixth person needed three or more attempts to login to the online survey.

WISE Introduction Page

The *introduction page* or *welcome page* of the survey is displayed when the user has successfully logged in to the survey. This is the very first page of the WISE questionnaire but does not contain any questions.

The user first gets informed about the structure of the questionnaire. The survey contains questions about different aspects of the complaint itself and questions about related aspects. The participants are asked to answer each question individually and to the best of their knowledge. The second paragraph explains to the user how they can navigate through the survey and how to pause the survey and continue later. At the end, the user can watch a more detailed instruction video by clicking on a provided link.

Understandability of the Introduction. This question asked how well the participants understood the introduction page of the survey.

Two-thirds (65%) of the people found that the introduction was *fully understandable* and the rest (34%) found that the text was *sufficiently* understandable. Only 2 out of 320 found that they only *barely* understood the introduction (see Figure 4.3).
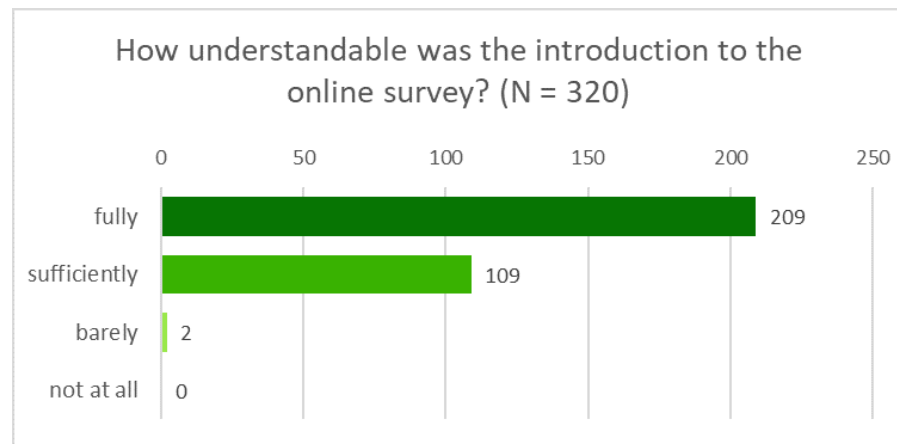
Figure 4.3: 99% of the participants found the introduction page sufficiently or fully understandable.
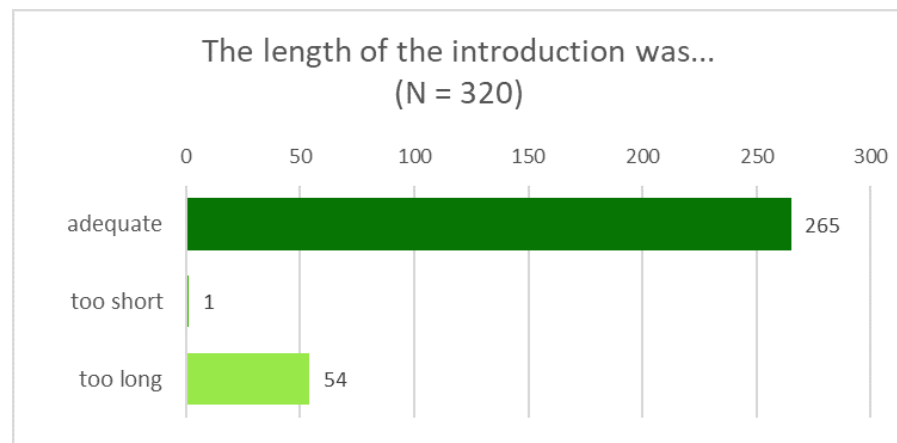
Figure 4.4: The majority (83%) of the participants found that the introduction had an adequate length and the others (17%) rather stated that it was *too long* than too short.

Introduction Length.   This question asked whether the participants found the introduction length to be too long, too short, or adequate.

The large majority (83%) of the participants found that the introductions length was *adequate*. The remaining 17% found the introduction was *too long* and only one person stated that the introduction was *too short* (see Figure 4.4).
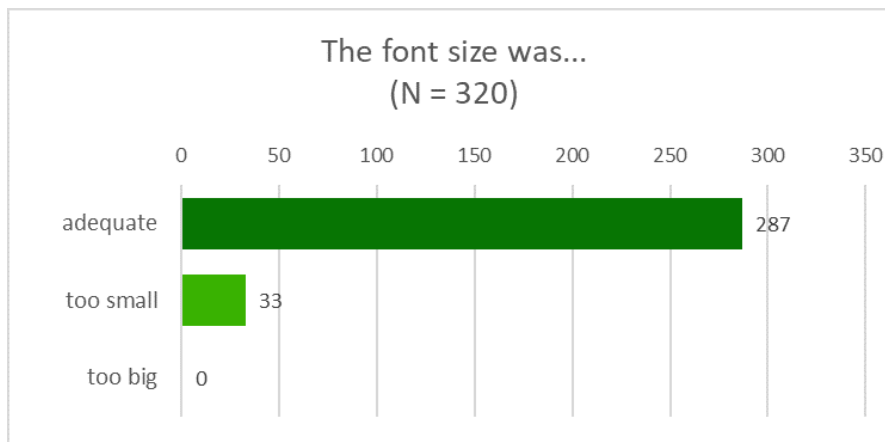
Figure 4.5: Only one out of ten thought that the font size of the intro-
duction was *too small*. The others (90%) found the size to be *adequate*.

Font Size. This question inquired whether the default font size used
in the introduction was too small, too big, or adequate. This ques-
tion referred to the default display of the font size, when the page was
shown with a 100% zoom factor. Today's most popular browsers sup-
port to zoom in and out of a webpage. With that a user can adjust the
font size him- or herself.

For 90% of the participants fond that the font size was *adequate*, while
the remaining 10% thought that it was *too small*. No one indicated that
the font size was *too big* (see Figure 4.5.

Video Instructions

The original WISE survey included four instruction videos. These
videos were meant as an additional aid for users who found the writ-
ten instructions insufficient. To access the videos users would have to
click on the corresponding video link. This then opens a new browser
tab in which the video is played.

The first video link was provided on the survey introduction page.
This video explained how users have to navigate through the survey
and how they can pause to fill out the survey and continue later. The
other three videos gave instructions on how users needed to complete
a special question type (further explained below). For this a link to the
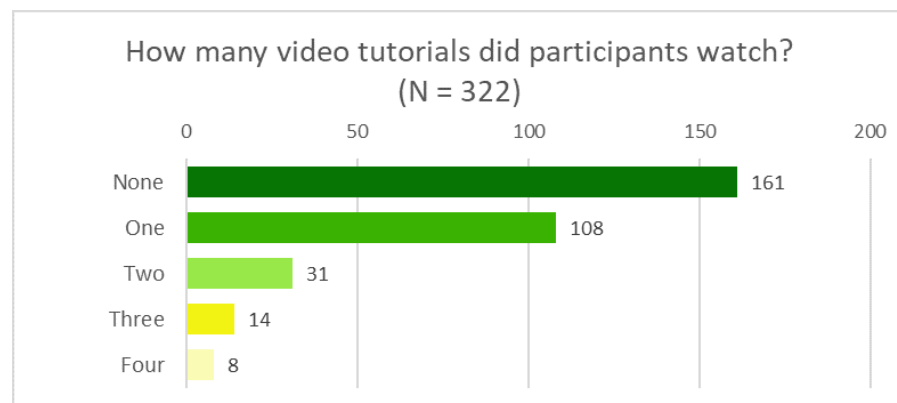
Figure 4.6: Half of the participants have watched none of the video instructions.

explanation video was included next to the question itself. The second video thereby explained how users could mark their pain on the *Pain Drawing* question. The third video gave instructions on how to complete the *Daily Pain Course* question and the fourth video explained how to enter their *Medications* correctly.

Video Instruction Usage.   This question asked participants to mark which video instruction they had watched. Due to a bug in the survey logic there are two more answers (N = 322) than in the previous questions.

The answers showed that half of the participants (50%) have watched *none* of the videos. A third (34%) of the participants had watched *one* of the tutorial videos, 10% had watched *two*, and the remaining 6% had watched *three or four* videos (see Figure 4.6).

Of the four different videos, the video tutorial about the Pain Drawing question was watched most often. Of the 50% who had watched at least one video, two-thirds (65%) viewed the one about how to fill out the Pain Drawing question. The second most frequent watched video was the instructions of the Daily Pain Course question (41% of the people who used the videos). With 45 views (watched by 28% of the people who've seen at least one video) the video about how to navigate and fill out the survey was watched the third most often. The video about the Medication Recording was watched least often (only by 18% of the video watchers) (see Figure 4.7).
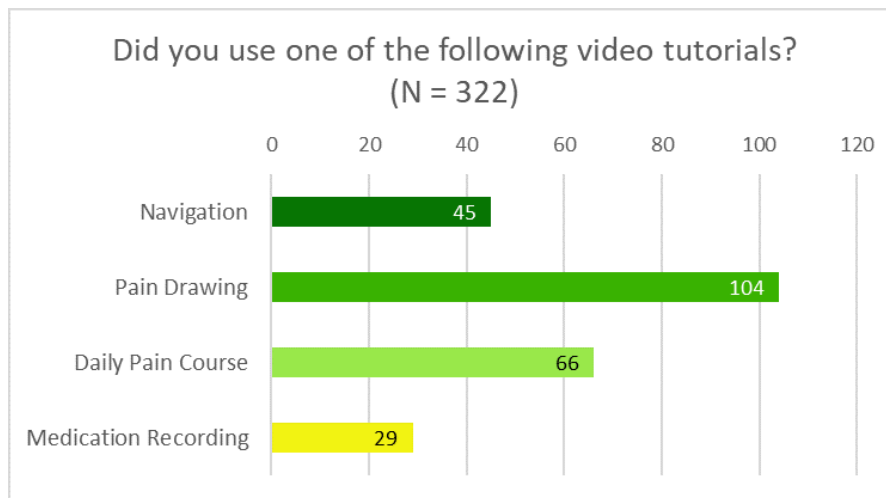
Figure 4.7: The instruction video about the *Pain Drawing* was watched most often. This could be an indicator for some usability problems.

User might have different reasons to watch the provided videos. Some might just be curious; others might need the richer video format to understand what they should do. Knowing that half of the users were able to fill out the survey without needing any additional instructions is already a good finding.

Figure 4.7 shows that the four videos were watched with a different frequency. Assuming that most users want to fill out the survey as fast as possible, we can argue that the videos were mainly watched, because the users had problems in filling out certain questions and understanding the instructions. The frequency with which the videos were viewed therefore could be taken as an indicator for the usability and understandability of different survey parts. Based on this assumption, users might find the Pain Drawing question the least understandable. And they would have more problems filling out the question about the Daily Pain Course, than to enter the Medication that they take. Whether this conjecture holds true, is investigated in the sections below.

Helpfullness of the Video Instructions. In this questions the participants of the WISE survey, who had watched any of the videos, were asked to rate how helpful the video was for them.
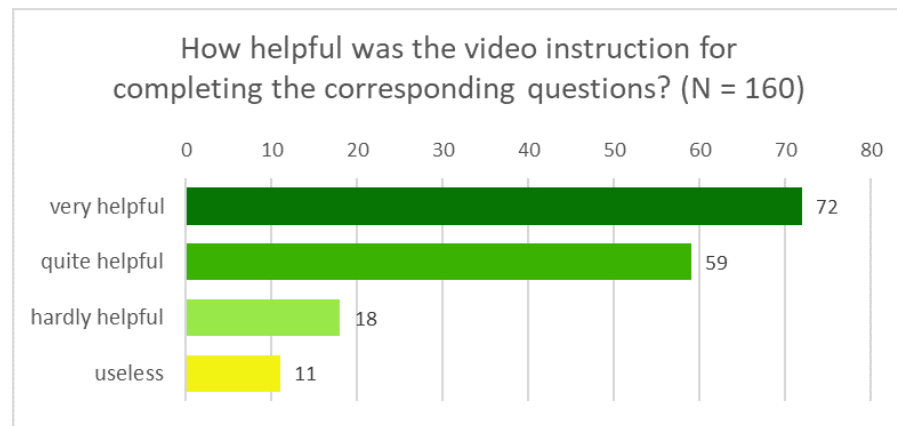
Figure 4.8: The majority (82%) of users thought that the videos were *very* or *quite helpful*, every fifth person (18%) found the videos *hardly helpful* or even *useless*.

Of the 160 people that have answered this question, 45% have rated the video to be *very helpful*. Another 37% found that the video was *quite helpful*. Almost a fifth of the people thought that the videos were *barely helpful* (11%) or even *useless* (7%) (see Figure 4.8).

Knowing that the majority (82%) of people rated the videos to be very or quite helpful is good. This means that users got some value back from the time they invested to watch the videos. However, every fifth person couldn't benefit from the videos which means that there is still some room for improvement. Ideally the surveys structure and questions would be self-explaining to a point that the users wouldn't need additional support from videos.

Pain Drawing Question

The WISE survey includes three different pain drawings in which users can specify the areas in which they feel pain, as well as the degree of their pain. The first pain drawing includes images of the head and the mouth, the second image shows the whole body from behind, and the third pain drawing shows the upper body from the front (see Figure 4.9).

These pain drawing questions are only shown to users, who indicated
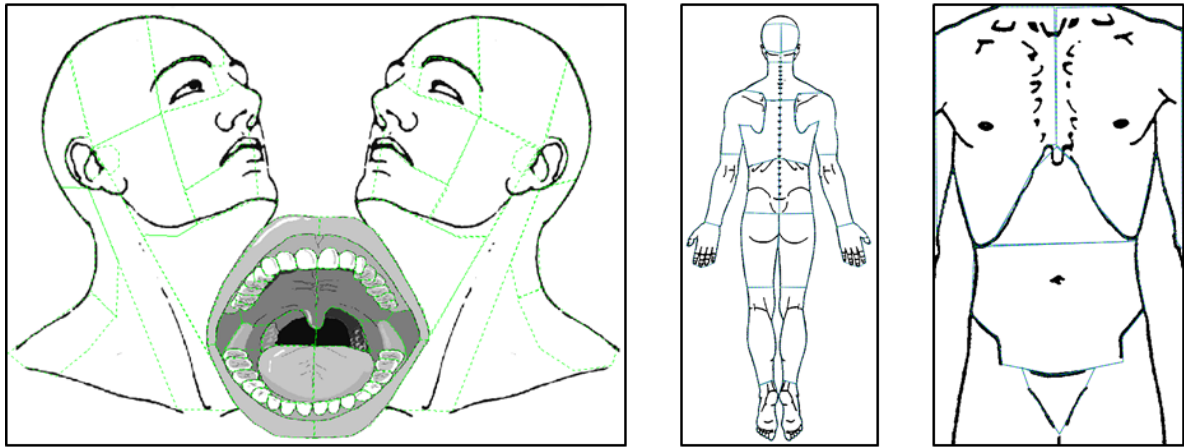
Figure 4.9: Pain Drawings from left to right: Head, Body, and Torso.

that they experience pain in a certain area (head, body, torso). Users who for example indicated that they suffered from pain in the head region would see the pain drawing of the head.

To fill out this question users first have to specify which of the image sides that they perceive to be the right or left side. To understand why this question is important, look at the image of the two heads in Figure 4.10. You could for example state that the right side of the image is at the same side as the right side of this page. You would then label right and left from a viewer's perspective. When entering your pain into the face, it would then look like a mirror image of yourself. The other possibility is that you would see the head drawing from the perspective of the subject itself. Meaning that the right side of the head would be on the same side, as the left edge of this page. In this case you would label the image with the *proper right and proper left side*, because the labelling no longer depends on the viewers perspective, which can change, but it would be from the subject's viewpoint, which stays the same (Wikipedia contributors [2019b]).

The practitioner of the orofacial pain unit included this question, because they found that about a fifth of their patients were confused with the proper right and proper left labelling, because they wanted to indicate their pain on their respectively the viewer's left and right. Practitioners want to be sure that they are talking about the same right side as their patients. To ensure this, patients were asked to explicitly state which side they perceive as right or left (see Figure 4.10).
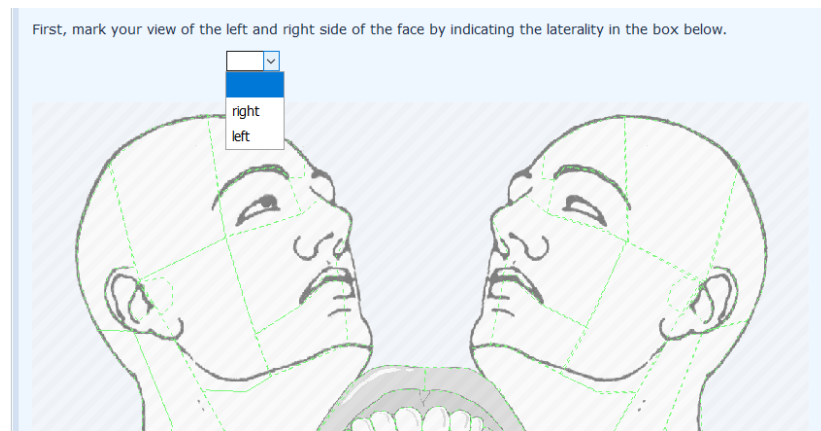
Figure 4.10: User first had to define which side they perceived as left or right.

Figure 4.11: To specify pain in a certain area, users first had to click on an area and then fill out the pop-up that you see in this image.

In a second step, users could then click on the different areas that were marked on the image to indicate the places that they feel pain. Clicking on one of these areas triggered a pop-up window (see Figure 4.11) in which patients were asked to rate their pain at rest and while moving from a scale from 0 (no pain at all) to 10 (worst imaginable pain).

In the pain drawing the filled out pain intensity would then be displayed as a lighter (less pain) or darker (stronger pain) shade of red (see Figure 4.12). Users could mark as many areas as they wanted.
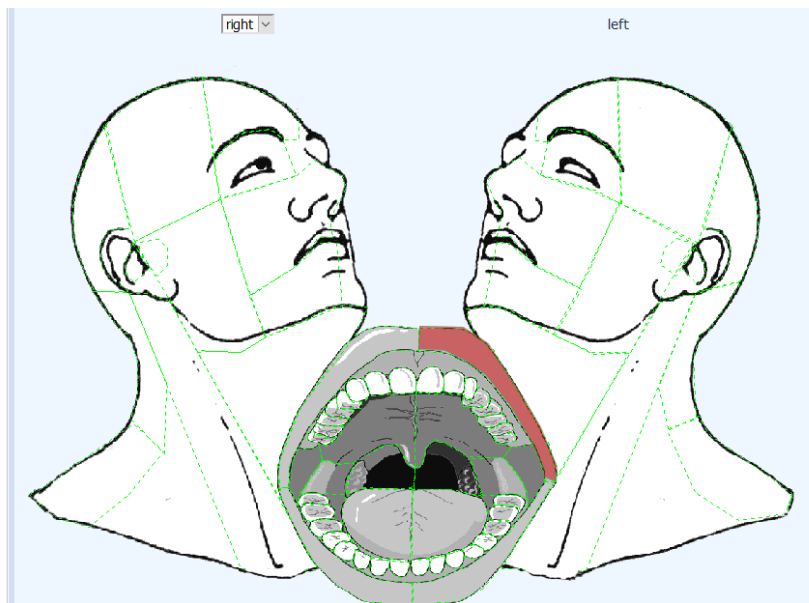
Figure 4.12: The pain intensity of an area is displayed as a shade of red.

Understanding of left and right Indication. In this question, people who filled out at least one of the Pain Drawings were asked to rate the easiness of indicating the right or left side of the Pain Drawing. The number of responses is more than twice as high (N = 738) as in the previous questions. This was due to a mistake in survey logic, which also showed this question to people who didn't want to give additional feedback.

The majority (56%) of the participants stated that they understood *immediately* how to indicate the right and left side. Another 34% understood what they had to do *after short consideration*. The remaining 10% of people equally figured it out *after long consideration* (5%), or it *remained unclear* (5%) to them how to indicate left and right in the drawing (see Figure 4.13).

Easiness to specify the Pain Location and Intensity. The second question about the Pain Drawing asked how long people used to understand how to specify their pain in the drawing. The number of responses was almost as high (N = 726) as in the question about the left and right indication.
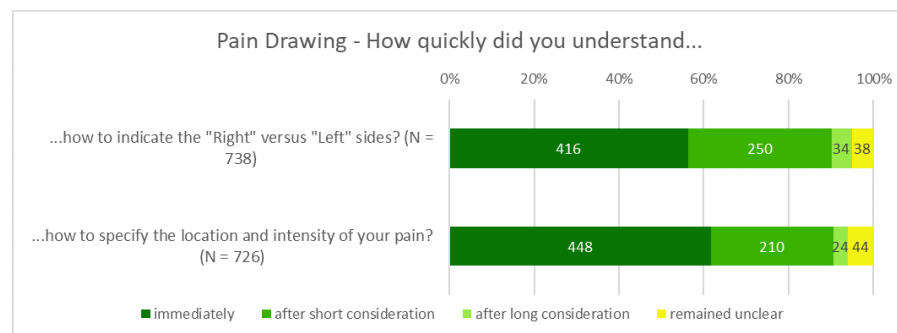
Figure 4.13: The answers of the two questions imply that specifying the location and intensity of the pain was a bit more intuitive than indicating the left or right side of the drawing.

Almost two-third (62%) of the user found that they knew *immediately* how to indicate pain in the drawing. 29% found that they knew what to do *after short consideration* and 3% *after long consideration*. How to specify the pain in the drawing *remained unclear* for the rest of the users (6%) (see Figure 4.13).

The responses indicate that the pain specification was a little bit more intuitive than the right and left indication. It is nice to see that only about a tenth of the users had difficulties to understand the questions about the Pain Drawing. Still, knowing that at least 38 people couldn't figure out how to indicate right and left and another 44 couldn't figure out how to mark their pain on the drawing, we think that there might be some space for improvement.

Diurnal Pain Course Question

The Diurnal (or daily) Pain Course question group requests the users to declare how much pain they felt during which part of the day. Participants had to specify the level of pain they felt for every 3 hours interval during the day (starting at 06:00 and ending at 24:00) and for one 6 hours interval at night (from 00:00-06:00) (see Figure 4.14).

Participants can click on the bars or drag and drop the slider to choose a pain value between 0 (no pain) and 10 (worst imaginable pain).
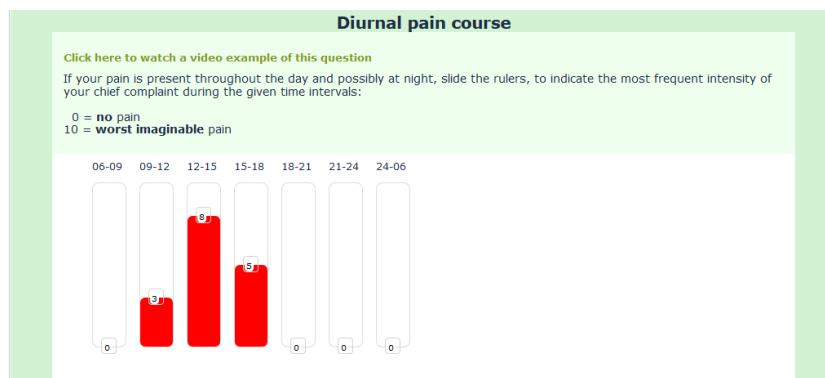
Figure 4.14: Users were asked to mark how much pain they felt during which time of the day.
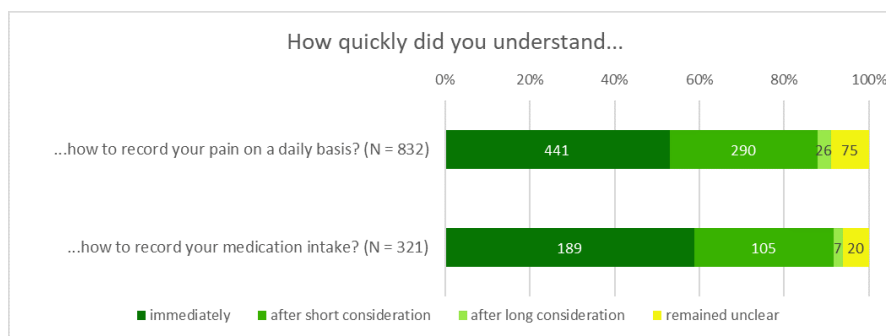
Figure 4.15: Most of the users understood how to fill out the question about the Diurnal Pain Course and the Pharmalogical Treatment *immediately*.

Easiness to record the Diurnal Pain.   This question asked the users how quickly they understood how to record their pain in the Diurnal Pain Course question. This question got the highest number of answers (N = 832) of all closed questions.

Only about half of the users (53%) understood the task *immediately* and another third (32%) knew what to do *after short consideration*. Surprisingly the number of people, for which the way to fill out the question *remained unclear*, was the highest out of the the questions that evaluated a special question type. Almost every tenth user (9%) didn't understand how to fill out this question and 3% figured out what to do only after *long consideration*.

Figure 4.16: Users could record one medication after another. For this, users needed to fill out all the questions and then click on *"done"* or *"enter further medication"*.

From a questionnaire designer's view point the Pain drawing question seems way more complex. We therefore turned our focus on the Diurnal Pain Course questions to find out why every tenth person couldn't figure out what they had to do.

Pharmalogical Treatments

In the old WISE survey, participants were asked twice to list the medications that they are taking. The user first needed to record all pain medications that they were currently taking and in a second step, all the other medication could be included. Participants could record several medication by clicking on *"done"* or *"enter further medication"* on the input mask of this question (see Figure 4.16).

Participants had to answer several question about the medication that they were taking. Only when all the questions were answered, the medication could be entered to the list. Users could also modify an existing medication, by clicking on the corresponding item in the *"Registered medication"* list (see Figure 4.16).

Easiness to record Medications.   This question asked the users how quickly they understood how to record their medications in the Phar-
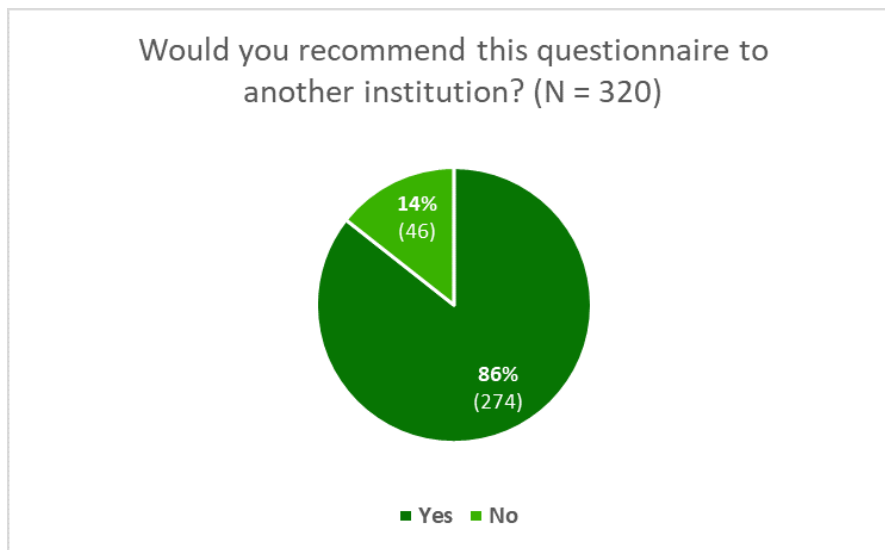
Figure 4.17: Caption

malogical Treatments question.

This question got 321 answers and the majority (59%) of the users indicated that they *immediately* understood how to fill out this question group. Another third (33%) of the users understood how to do it *after short consideration*. Only 2% of the user stated that they only understood the question *after long consideration*, but for 6% it *remained unclear* how they have to fill out these questions (see Figure 4.15).

Recommendation to other Institutes

The last closed question wanted to know whether the participants would recommend the WISE questionnaire to another institute. 86% of the users stated that they would recommend the survey, the remaining 14% would not recommend the survey to an other institute (see Figure 4.17).

This question shows that most of the patients of the orofacial pain unit found some value in filling out the WISE survey. The reasons for not recommending the survey were captured in a separate question, which is discussed in Section 4.1.3.

4.1.3   Open Questions Evaluation

The analysis of the open-ended questions showed to be a bit more complex. We initially used an excel template[1] to classify the comments into different categories. In a second step we used the initial categories, printed them on paper cards, and sorted them into general answer groups. We did this for each of the two open questions separately and combined all answers into one big diagram. This process is very similar to the process of creating a proper affinity diagram, except that we had pre-classified the answer into different answer categories and used them to create the diagram. In a later step we added the individual comments to the affinity diagram, to provide deeper insights.

The analysis of the open questions showed, that people had often written more than they were asked, or even wrote about a different topic. Some people (more than 30 answers) used the open text input to include information that they couldn't state anywhere else. For example, they've used the open text input to elaborate about their medical condition, to inform about encountered usability problems, or simply to express their appreciation towards the clinic.

We will first investigate the reasons why, people wouldn't recommend the WISE survey (see Section 4.1.3) and then have a look at the answers to the question about what was missing (see Section 4.1.3).

No-Recommendation to other Institutes

The participants who wouldn't recommend the WISE survey to other institutes (see Section 4.1.2) were asked about the reasons why. A total of 44 people answered this question and the results are described below.

The different comments that were made to a topic are summarized in bullet points. The number in brackets at the end (e.g. **(4)**) indicates how often this comment was stated. Direct quotes are *italicised*. Note that one answer could contain comments about more than one topic.

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[1]Louis Grenier. How to analyze open-ended questions in 5 steps, 2018. URL: https://www.hotjar.com/blog/analyze-open-ended-questions/. [Online; accessed 7-Mai-2019].

The Survey is too long and complex. This is the reason for not recommending the survey, that was stated the most.

Comments mentioned on this subject:

- Too long (14)
- Too time-consuming (6)
- Too complex (6)
- Too broad and detailed (5)
- Many questions are very similar (5)
- Too general (1)

The general length of the survey, the complexity of the questions, and the time needed to fill out the survey, seem to be major issues of the survey. One person mentioned, that you have to be a native German speaker to comprehend and fill out this survey. And another participant doubted that patients would be willing to fill out such a survey, if every institute would use a similar one.

Irrelevant for the own Case. Another reason why participants wouldn't recommend the WISE survey, is because they felt that the questions that were asked, didn't match their complaints. Similar to this, several users found that they couldn't describe the issues that they actually wanted, because the corresponding questions were missing.

Comments mentioned on this subject:

- Irrelevance for the own case (7)
- Insufficient possibilities to describe your own complaints (5)
- A one-to-one appointment is preferred (4)
  "I'd rather explain how I'm doing in a conversation."
  "I feel this is an unnecessary step into de-humanization of health care."
  "In the consultation everything will be re-discussed anyway [...]."
- For patients that don't suffer from a lot of pain (3)
  After this questionnaire, where you have to classify your pain about 20 times on a scale, you feel stupid to go to a specialist at all if you have only little severe pain.
- Unnecessary if the cause of the problem is known (1)

We don't know for what problem the participants went to the orofacial pain clinic, nor do we now which questions that they found unfitting

for their own case. The only hint we can pursue, is why people without bigger pain issues had to fill out so many pain related questions.

Usability Problems are another reason why people wouldn't recommend the WISE survey. It seems that some people encountered a couple of different problems while filling out the survey.

Comments mentioned on this subject:

- Problems with the user interface (4)
  "The font is too small."
  "There are more beautiful web-based questionnaires."
- Difficulty to specify pain (4)
  "Pain is known to be very subjective and cannot be described when taking painkiller."
- Problems with the medication recording (2)
- Entry of the pain frequency doesn't make sense (2)
  "The intensity of pain varies over days and weeks, not necessarily during the day."
- Problem with the pain drawing (1)
- Login problems (1)
- Problems with the video (1)
  "At the end of the first video I could neither go back to the questionnaire directly, nor finish, or log out. To fill out the questionnaire, I had to log in again and skip the video."
- Obscurity about the survey length (1)
  "It is hidden how long the questioning takes. Certain questions are not asked."

The answers indicate that there were problems with some of the special questions that are included in the WISE survey. The Pain Drawing, Pharmalogical Treatment, and Diurnal Pain Course questions were mentioned explicitly. Another problem is related to the subjectivity of the pain. It is a common problem when trying to measure pain. Even when you offer a scale, the indicated pain intensity will still be subjective, but this is unavoidable.

Missing Content and other Comments

In this question, participants were asked whether anything important was missing in the questionnaire. While inspecting the answers, we found that many people had used this question to include additional information about their case (N = 33), or to write about problems they had encountered while filling out the survey. A total of 153 participants have answered this question. In the following paragraphs, we will provide an overview of the topics and problems that were mentioned.

The different comments that were made to a topic are summarized in bullet points. The number in brackets at the end (e.g. **(4)**) indicates how often this comment was stated. Direct quotes are *italicised*. Note that one answer could contain comments about more than one topic.

Missing Content. The answers to this question revealed a large spectrum of information which people felt were missing. In most of the answers, the need to be able to include additional information about special aspects of ones condition or medical history was very prominent.

Comments mentioned on this subject:

- Possibility to describe the complaints in your own words (8)
  "More possibilities to describe in one's own words; especially in the indication or more detailed description of the pain and the psychological condition."
- A field for additional remarks and information (7)
  "The section 'Other comments' at the end of the questionnaire is missing."
- Question about the history of the chief complaint and other complaints (6)
- Other previous and ongoing treatments and diagnostic confirmations (6)
  "A more detailed description of the preliminary examinations or doctors already visited"
- Option to write about the own metal distress (4)
- Other physicians in charge (4)
- Differentiation between new and overall illness (2)
  "It was usually not clear to me whether the questions only referred

to the new illness or to the whole. Therefore, it was often difficult to answer."
- Ability to print out the survey (4)
- Being able to add documents related to the case (3)
  e.g. medical report, medication list, allergy ID
- Question about the reason of the treatment (1)
- Ability to give details about inaccuracies (1)
- Question whether one was previously treated at the clinic (1)

Every patient has a different medical condition and treatment history. The answer show that for some patients the questions provided didn't cover all the relevant aspects of their medical case. We therefore need to include more open-ended questions in the survey to give these patients the option to include more informations about their case. We also need to make sure, that we include a question for final remarks at the end of the survey, where patients can write down everything that they couldn't express previously.

The inclusion of other documents at the moment is not supported by the WISE and the WISE survey. At the first appointment patients should bring these documents with them.

Survey is too long and complex.   This issue was already mentioned several times in the previous section (see Section 4.1.3). An additional 7 people mentioned that the survey was too long and 4 mentioned that the questionnaire was too complex. One person for example replied this to the question whether anything was missing: *"No, probably too many questions if anything."*

Irrelevant for the own Case.   This issue was already discussed in the previous section (see Section 4.1.3). An additional 6 people mentioned that many questions of the survey were irrelevant for them. Of these 6 answers, 4 people also indicated that their complaint was not related to pain and that they therefore had difficulties filling out the pain-related questions.

Usability Problems.   A large amount of answers included information about possible usability problems that users encountered while filling out the survey. The pain drawing questions are the ones that

most people struggled to fill out. We also found that the questions about the diurnal pain course and the medication recording in the pharmalogical treatments section, caused problems for some users.

Comments mentioned on this subject:

- Problems with the pain drawing questions (31)
    - Problems when entering right and left
    - Unable to change the entries afterwards
    - Problems with the pain drawing of the head
    - Problems with the pain drawing of the body
- Problems with the daily pain pattern questions (8)

    - The size of the question was too small

    - Unable to remove false entries

    - Pain course exceeded the 24 hours frame of the question

    - A field for further explanations is missing

- Problems with the pharmalogical treatment questions (8)

    - Unable to edit entries

    - Recorded entries were deleted after changing the page

    - No trust in "Medication saved" led to double entries

- Other issues (16)

    - Obscurity about the duration of the survey

    - Missing overview throughout the survey

    - Writing and navigating through the survey was difficult because the items were too small

    - One question was in English instead of German

    - One question field was empty still required an answer

- No possibility to skip irrelevant questions (1)

The root of the problems mentioned above was often not possible to trace back. One reason is the ambiguous explanation of the users and the other is that the WISE survey has been improved over the years and many bugs were already corrected. Therefore, we can't know which problems still exist in the current survey version, but we do now which areas are especially prone to errors. Conduction some user testing with the current version of the pain drawing, diurnal pain course, and pharmalogical treatments question groups, could reveal current the flaws of these questions.

The issues with the missing overview of the survey and the survey objects that were to small, do need to be investigated further.

Problems with the Quantification of Pain.   The last issue that was mentioned quite often, is that the participants found it difficult to classify and quantify their pain problems. A total of 27 different comments were made that were related to this category.

The reasons why participants found it difficult to quantify their pain were multiple. Some participants just mentioned that pain was very subjective and that it was difficult to assign a number or to it. For other pain patients the specific questions of the survey somehow didn't match the complaints that they experienced. In many of the answer the participants described very unique characteristics of their pain. Or patients who suffered from several pain issues mentioned that they found it difficult to differentiate between them. Some patients who felt no or only little pain stated that they couldn't properly answer the pain questions, because their main complaint was a pressure, tightness, or hypersensitivity.

The fact that pain can change over time, was another source for problems. Some questions asked about the average pain in the last month. If the pain level fluctuated a lot or changed drastically during this time, then patients would have difficulty to determine the average value.

Offering more open-ended questions could be a way for such patients to express better how they felt and what part of their complaint didn't match the WISE questionnaire.

4.1.4   Implications

From the closed question analysis we know that 43.0% indicated that they haven't faced any difficulties, however almost 20% of the users wrote that they encountered difficulties, but didn't want to give additional feedback. And from the remaining 37% that gave feedback, 15% (5% of the total number of participants) stated that they wouldn't recommend the survey.

While the feedback of the closed questions seemed like the survey

was well made and understandable, the analysis of the open-ended question answers uncovered several problem areas. The next paragraphs describe, which actions we planned to address the problem we thought were most important. Because we couldn't pursue every negative comment that was made, we will focused on the actions with the greatest positive impact on the usability of the survey.

Shorten and Simplify the Survey.   The length and complexity of the survey was one of the main reasons that users wouldn't recommend the WISE survey. As a consequence we need to try our best to eliminate unnecessary questions and structure the questionnaire in a way that would shorten the completion time. As a first step to do so, we had a closer look at the survey logic to detect redundant questions or faulty logical conditions (see Section 4.2).

Investigate and improve the special Question Types.   In the open question analysis, participants have mentioned a variety of usability problems that they encountered, while filling out the one of the following question types: Pain Drawing, Diurnal pain Course, or Pharmalogical Treatments. These questions were all custom made for the WISE survey. To improve their usability, the problem areas of these questions were investigated by user testing, and the new solutions were developed with a user centred approach.

Offer more Options to enter additional Information.   Many people have used the open-ended feedback questions to include more information about their case, instead of answering the initial question. Several participants have also stated explicitly that they missed text fields where they could explain their condition in their own words. To improve this, we first needed to get a deeper understanding of the content and structure of the WISE survey (see Section 4.2).

4.2   Survey Logic Analysis

From the user feedback evaluation we know that the WISE survey is very long and comprehensible. We also discovered that several people had to fill out many pain specific question, even though they didn't
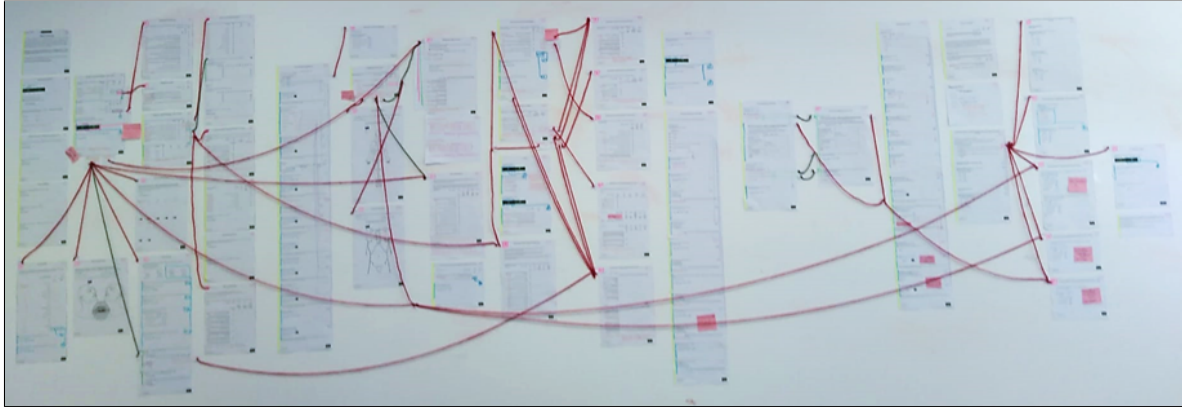
Figure 4.18: The finished WISE survey logic diagram spanned a whole wall. The red and green threads represent logical connections between different survey parts.

suffer from pain at all. To further investigate these issues and get a better understanding of the content of the WISE survey, we decided to inspect its survey logic. By understanding the logic of the survey we also understand how its questions are interconnected with each other.

Section 4.2.1 will explain the methodology we used to investigate the survey, and gives guidance, on how a similar strategy could be used to investigate issues of another complex survey. Section 4.2.2 then provides an overview of the issues that were found with this approach.

4.2.1   Making the Survey Logic visible

In this section we will explain how we created a tangible diagram of the logic of the WISE survey. While this approach was used for this particular survey only, we believe that other researchers which have to work with large and complex surveys could also benefit from this approach.

Motivation

The reason to create a survey logic diagram of the WISE survey, was to understand how different parts of the survey were related to each other, as well as to uncover possible mistake in the logic itself.
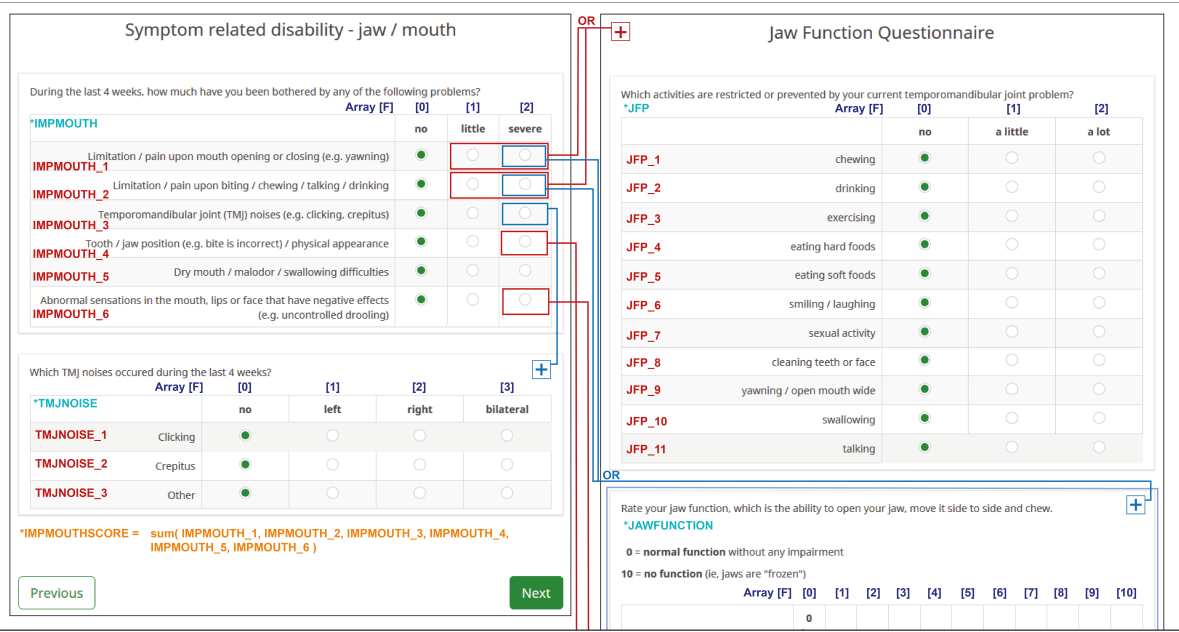
Figure 4.19: An extract of the WISE survey logic diagram that was drawn in *Adobe Illustrator*.

We initially started to draw the survey logic diagram on the computer, using *Adobe Illustrator*. We used screen shots of the survey as a basis and then drew the question labels and logical connections on top of these images (see Figure 4.19). It took us over a week to merely complete about a quarter of the whole diagram. The process of doing so in Illustrator was very cumbersome and time consuming. The larger the diagram got, the harder it became to manage and structure the large amount of independent graphic elements. In addition, the overview of the diagram became very poor and it was difficult to trace logical connections between questions back and forth.

Therefore, we decided that it would take too much time to complete the diagram in this manner. As a consequence, we took a step back and decided to create the survey logic diagram manually without the help of a computer program.

The following paragraphs describe how we built this diagram and how we used it to detect possible problems. To conclude, we demonstrate the benefits of this hands-on approach as well as its limitations.

Hands-on Survey Logic Diagram Investigation

The process to visualize and investigate the survey logic contains several steps. First you need to gather all the materials, then you create the paper-based logic diagram, and in a last step you have to go investigate the diagram, and record the problems found. Figure 4.18 shows how the survey logic diagram of the WISE survey looked like when it was finished.

Preparations.   Before you can start to create the logic diagram, you have to gather and prepare all the materials needed. First of all, you should think about the space that you want to create the diagram in. Depending on the size and complexity of your survey, the diagram might easily fit on a white board or you could need the space of a whole wall (like in our case).

In a second step, you would have to prepare a printable file which contains images of all the questions and question groups used in the survey. For this step, we took screen shots of the WISE questionnaire and combined them together in one large file using Adobe Illustrator. We arranged the question screen shots in a way that we could print them on A3 pages. For this step it is very important to capture all possible questions that are asked in the survey. Make sure that you do not accidentally forget a question because it is only shown under certain conditions.

Another important artifact is a list with all logical conditions that are implemented in the survey. If the different survey questions have a unique label, as the ones in LimeSurvey do, and the label is used to specify the survey logic, then you also need a list of the labels and corresponding questions. In LimeSurvey you can use the *Survey logic file* to obtain these information (*in LimeSurvey: your survey → Settings → Tools → select the language of the survey logic file*).

Other materials that are needed include sticky notes and pens in different colors, to highlight and mark special properties; several meters of thread to mark the logical connection between different parts of the survey; and utensils to stick the question printouts the wall. We used a removable glue stick for this task. With this glue stick any type of paper can be converted into a sticky note.
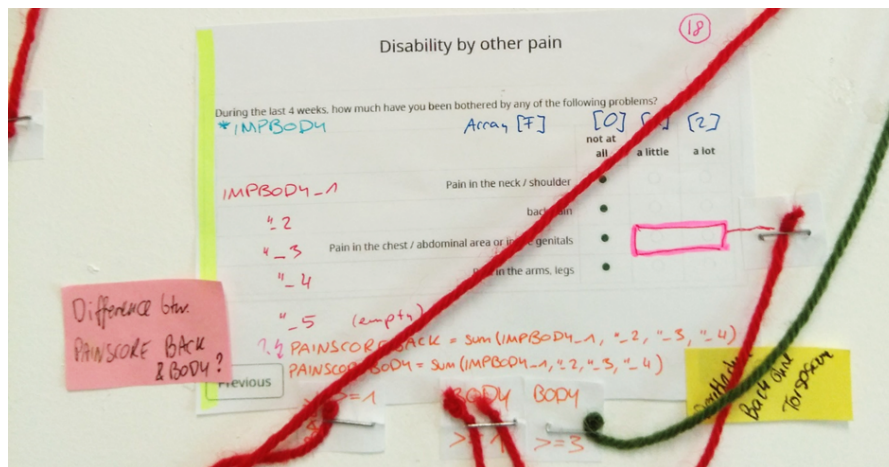
Figure 4.20: The label names of the questions are marked with red and blue pens, and the score names and calculations are written in orange.

In short, you need the following *materials*:

- Printout of the **survey screen shots** including all question groups and questions
- Printout of the **survey logic file**
- A **wall**, white board, or the like to put the diagram on
- **Removable glue stick**, tape, magnets, or pins to fix the diagram parts
- **Thread** (if needed in different colors)
- **Staple** to fixate the thread
- **Sticky notes** in different colors and sized
- **Pens** in different colors

How to create the Survey Logic Diagram. First, cut out the question groups from the printouts such that every page contains all the question of one question group. When you have question groups with a long list of questions then you might need to glue several pages together.

Second, write additional information that is relevant for the survey logic onto the pages. If your survey uses unique labels to refer to its questions and the implemented survey logic refers to this labels, then you need to write the label name next to their corresponding question (red and blue marks in Figure 4.20). We recommend to do this first, before starting to mount anything to the wall. This way, the labelling
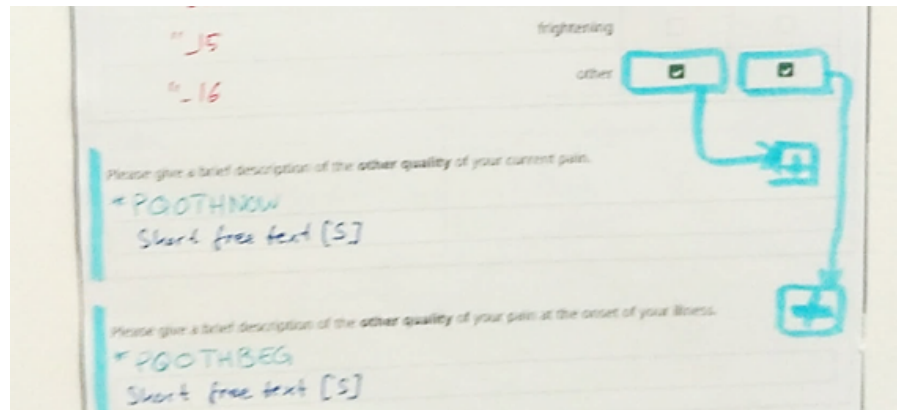
Figure 4.21: The blue marker shows which answers need to be selected such that the two questions below are displayed.
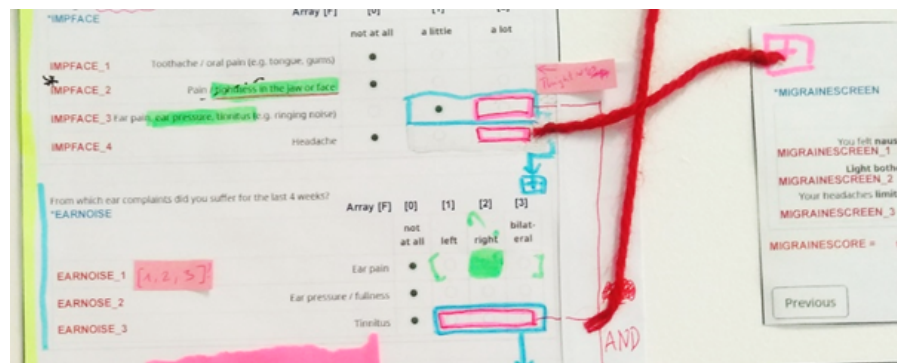
Figure 4.22: The red lines and red thread shows how logical conditions between question groups were visualized.

of the questions can conveniently be done at a table. If your're calculating scores within your survey which influence the survey logic, then you also need to write them down (orange marks in Figure 4.20).

Third, stick the question group pages onto the wall and start to record the logical connections between different parts of the survey. Logical conditions within a question group can be drawn directly onto the pages (see Figure 4.21). We drew a frame around answers options that would trigger the display of another question, and then drew a line between them, to indicate their connection. At the end of this connection line we would write a **+** symbol to mark that this question is displayed, when the answer of the previous question is selected.
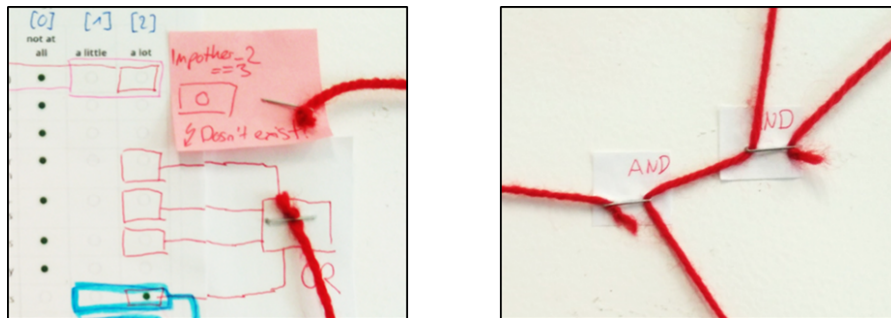
Figure 4.23: Complex logical conditions can be visualized by writing the logical operation next to the lines (left image) or threads (right image) that need to be combined.

Logical conditions that span between question groups are visualized best by using a thread to connect them, but the concept stays the same (see Figure 4.22). To position the start and end points of the thread, we found that it worked best, when we made a knot into the thread and then stapled it on a small piece of paper. This paper was then glued (with the removable glue stick) to the wall (see examples in Figure 4.23).

In the case that the survey includes more complex conditions using *AND* or *OR* logic operations, you can indicate them by writing them next to the place where the lines from the answers meet (see right part of Figure 4.23). The same is possible when threads coming from different question groups are combined into one logical condition (see left part of Figure 4.23).

In short, you have to perform the following steps:

- Cut out all the screen shots of the question groups
- Write all question labels on the question printouts
- Write down all scores and how they were calculated
- Fixate the question groups on the wall
- Draw the logical conditions within a question group directly into the printouts
- Mark the logical conditions between different question groups with a thread

Inspect the Survey Logic Diagram.   After completing the diagram take some time to thoroughly inspect the result. Take two steps back

and look at the diagram from afar.

Are there any interesting patterns? For example:

- Are there any answers that have a large impact on many of the following questions?
- Are some questions only shown when many conditions are met together (AND operations)?
- Are there questions which are triggered by several answers (OR operations)?
- Do you see any question groups that belong together?

Next, have a closer look at the causes and consequences of these patterns. Write down any interesting finding on a post-it and place it next to the related questions or conditions.

To find other problems in the survey and its logic, walk through the survey from the beginning to the end. Read all the questions and their answers. Pay special attention to any logical condition that you've recorded in the diagram. Note down anything that you don't understand or could be a possible mistake. Put these notes close to the places where you found any kind of problem.

Conduction a Walkthrough Meeting.   In the case that you haven't developed the survey yourself and are no expert in the topic that the questionnaire inquired about, arrange a meeting with the people who do have the expertise and decisional power. The previous inspection and note taking of problem areas, will be a good preparation for the meeting. Depending on the complexity of your survey, schedule enough time for the meeting. We used about 2.5 hours to go through the whole survey logic diagram with a group of three people.

In the walkthrough meeting first give a short introduction about how you created the diagram. Explain the meaning of the different elements (drawings, thread, post-its), such that all can read and understand the diagram. Maybe give your colleagues a bit of time to have a quick look at the diagram. Then start the group discussion with one or two problems that you found crucial. Use the remaining time to guide your guest through the survey from the start to finish. Try to discuss every problem, but also give the participants of the meeting some time to inspect the diagram themselves.

During the meeting, use a different color of post-its or pens to write down the answers to your questions and the decisions made.

The goal of the walkthrough meeting is to validate, that the problems you've found are actual problems and to get clarity about the aspects that you found confusing. Finding solutions to some of the problems might be a welcome outcome, but it is not the main focus of this meeting.

Record your findings. The last step, is to record your findings. As soon as the meeting is over, take pictures of the finished survey logic diagram. Make sure to have overview pictures of the diagram, as well as detailed pictures of all question groups, with readable labels and logical conditions. In addition, create a document in which you write down all the problems that you found, newly acquired information, and decisions taken. Where useful, include snippets of the survey logic image to facilitate understanding.

Benefits & Limitations

To conclude this section, we will outline some of the benefits and limitations that we have found, during the process of creating the diagram and holding the walkthrough meeting.

Benefits. The list below summarizes the benefits that we found when we created and worked with the physical survey logic diagram, compared to its (unfinished) digital counterpart. The goal of both logic diagrams, the digital as the physical, was to help us understand the survey logic and to find possible problems within it. Because the survey that we investigated is very huge and complex, we found that creating a physical instead of a digital diagram provided the following benefits:

- Time saving
- Diagram is easy to modify
- Physical diagram provides both an overview and a detail view
- Logical connections between survey parts are easily traceable
- Detection of patterns and connections is straightforward
- Engages people to explore the different parts of the survey

Creating a paper-based logic diagram saved us a lot of time. We initially started to create a digital representation of the survey logic, but we needed over a week to complete only about a quarter of the diagram. When we restarted from scratch and created a physical representation of the diagram, we were able to complete the whole diagram in less than a week. We also think that the analysis of the diagram was much easier and faster than it would have been with a digital representation. No clicking, scrolling, zooming in and out, or drag and dropping was needed. You can look at different parts of the diagram within very little time by simply walking around. It is much easier to keep an overview of the diagram.

In addition, we found that logical connections could be traced very easily, even if the different question groups were located quite far away from each other. You could just grab the thread and follow it. Spotting different logical patterns and exploring their causes was easier with this overview.

In the walkthrough-meeting together with the experts form the Orofacial Pain Unit, we also noticed that the tangibility of the diagram sparked interest and engaged everyone to explore it.

Limitations.   While we found that the paper diagram was the right choice for our project, we also know that it has some strong drawbacks. With its physical representation the diagram is bound to a physical location. Our survey logic diagram occupied almost a whole wall. It would have needed a large effort to take the diagram down and mount it at a different place, therefore we had to hold the walkthrough meeting in the room where the diagram was located. Such big diagrams don't allow remote access.

In addition, to the restricted movability of the survey logic diagram, the diagram is also very difficult to share with others. The only way to record the result of the diagram, is to take pictures of it. Unless you have a super high-resolution camera, you have to take many pictures of the diagram. But with this capturing method the good overview of the diagram gets lost.

4.2.2 Found Issues & Implications

In this section a summary of the different issues that were found during the survey logic inspections is given. In the subsequent section, the implications of these findings and possible next steps are discussed

Found Issues

Through the analysis of the survey logic diagram we found 65 smaller and larger issues. The complete list of issues that we have discussed, is available on the enclosed CD (see Appendix D). In the following paragraphs we briefly discuss different problem areas that we found.

The WISE Survey is very long! Having all the questions outlined in one large picture, the extent of the survey became visible. Fortunately, most of the patients will not have to answer every single question, but still the amount of questions that could be asked was huge (174 questions in total, of which many had several sub-questions). It became clear, that we need to find ways to shorten the time required to fill out the WISE survey.

Survey Logic Mistakes. By mapping out all the logical conditions we were also able to detect several flaws.

The biggest issue was with the screening question on *"Pain/tightness in the jaw or face"* (issues #2). If this question was answered with *"a little"* or *"a lot"*, a four other question groups would be displayed inquiring more about the pain of the patient. As a consequence, people who only felt some tightness in their jaw or face, but didn't have any pain problems would be asked very specific questions about their non-existent pain. As a solution we split the question in two. Pain and tightness would be inquired in two separate question groups.

We also detected two scores that were calculated wrongly (issues #3 and #31). These scores were included in some logical conditions and triggered the display of certain questions. For example, in issue #3 the pain score that was calculated for the head, only included pain of the

"right ear" instead of including ear pain experienced on the *"left"* or on both (*"bilateral"*) ears.

Another type of problem are screening question which had no influence on any of the questions that were shown later on. An example, is the *"Impairement by tinnitus"* question group which would be shown, if participants indicated that they suffer from a strong (*"a lot"*) tinnitus on any ear. Participants were additionally asked whether their tinnitus problem was already assessed by a specialist or not. But the answer to this question had no influence in the display of the *"Impairement by tinnitus"* questionnaire, which assessed the tinnitus complaints anyway. Therefore, the question about a previous tinnitus diagnosis was excluded.

Unnecessary Questions.   During the walkthrough meeting we were also able to find several unnecessary questions that could be removed. With the overview of all the questions that could be asked, it was easier to spot redundant questions inquiring about the same topic. Two whole standard questionnaires (issue #21 and #44)with a total of 15 questions were removed from the WISE survey.

Missing Questions or Answer Options.   In contrast to the previous paragraph, we also found two questions (issue #1 and #54) which included too few answer options. A good example is the very first question of the survey. The questions asked about the *"Gender"* of the participants and the answer option included *"female"* and *"male"*. This binary gender classification is outdated, because we know that the spectrum of gender is much more diverse [Jaroszewski et al., 2018]. Sadly this fact is often forgotten or ignored by researchers and software developers [Jaroszewski et al., 2018, Keyes, 2018]. Therefore, we decided to offer a third option, where people could classify their gender in their own words.

From the open question analysis of the user feedback (Section 4.1.3) we know that many people had used the question about missing content to write about their medical condition. We found that there were indeed very few open-ended questions that allowed the patients to describe their complaints in their own words. In addition, most of the open-ended question were asked at the beginning of the questionnaire. This is probably the reason why so many participants used the feedback questions to write more about their issues, not knowing that

these answers wouldn't be included in the patient report. Therefore, we decided to add a question that asked the patients whether they had any *"Final remarks"* to make, before they concluded the survey.

Clarification of Questions. One of the main goals of this survey logic analysis was to get a deeper understanding of the survey and shrink the knowledge gap of the unfamiliar domain. In the walk-through meeting many questions and uncertainties were clarified.

For example, different question groups inquired about different aspects of pain. The questions asked about how the pain felt like, the pain pattern, or the daily pain course. All three question groups depended on the screening question that asked whether the chief complaint of the patients was painful. But it wasn't stated if the question inquired about general pain issues or only about pain that was related to the chief complaint. Of course it would have made sense, that these questions concerned themselves about the pain from the chief complaint, but to be sure, we needed the to validate this assumption with the experts from the orofacial pain unit.

Complicated Writing and Spelling Mistakes. Many of the smaller issues that we detected had to do with the wording of the questions and question group titles. One problem that occurred several times, was the usage of medical language or jargon. Some examples include the words *Temporomandibular Joint* (jaw joint), *Crepitus* (grinding noises), or *Parafuction* (mouth/jaw related habits). Other sentences were just poorly written and difficult to understand, or they had a different meaning compared to the original German version.

Inconsistent Writing Style. Other, less severe flaws, were inconsistent formatting of the text and questions. Most of these issues included an inconsistent use of lower-case and upper-case letters. In two places (issue #40 and #51), the labels of the questions were accidentally written in another language (once in Chinese and once in Spanish).

Implications

We conclude the survey logic analysis, with a summary of the most important findings and an outline of the steps used to address the detected problems.

Correct the detected Mistakes.   The created issues list from the survey logic analysis, already contains different approaches for a possible solution (Appendix D). For every issue that was found in the survey logic analysis, we either decided that it wasn't a problem, or we decided to determine a solution to fix it. Most of these finding are already implemented in the new WISE version.

Reordering of the Question Groups.   The survey logic diagram revealed that parts that logically belong together were not always located close to each other. From the user feedback evaluation (Section 4.1), we know that some people felt like the survey included some redundant information, or that they sometimes forgot what they had written previously. Existing research about recognition and recall reveals that these findings are not surprising. People are much better in recognizing that something is similar (e.g. questions about a similar topic), than recalling any past event (e.g. recalling previous answers) [Johnson, 2013]. Question groups that inquire about a similar topic, should be grouped together. This simple measure supports people in remembering the answers they gave to similar previous questions.

The closeness of similar questions should also help people to recall the correct answer to the question they were asked. When several question ask about the same topic, people are likely to remember more because they have more time to reflect on the topic. This would also improve the quality of the answers gathered through the WISE survey. [Fowler Jr and Fowler, 1995]

We used the Card Sorting method by Spencer [2009] to determine the order in which the question groups should be displayed. The methodology and outcome of this card sort are described in Section 5.1.

Rewriting and simplifying of the Questionnaire.   With the survey logic analysis, we already found many locations of bad or flawed writ-

ing. In order to improve the readability and understandability further, we decided to keep looking for complicated, long, or incorrect writings.

As a step to do so, we decided to rephrase and restructure the introduction page of the survey (see Section 5.2).

Shorten the Time needed to complete the Survey. This statement was the final take away from the survey logic inspection. The physical representation reminded us of the length of the questionnaire. We expect that the patients will fill out the questionnaire to the best of their knowledge. But we must hold ourselves accountable to offer a questionnaire that uses the minimum amount of time to be filled out, while asking all the relevant questions.

This goal includes all the approaches that were described above. Reducing the amount of questions, improving the logical conditions, reordering the survey groups, and simplifying the wording of the questions and instructions will improve the user experience of the patients and hopefully decrease the time they need to complete the survey.

Chapter 5

WISE Survey Improvements

This chapter presents the solutions that we have developed to address the problems that were found though the user feedback evaluation (see Section 4.1) and survey logic investigation (see Section 4.2).

The next sections describe how the survey structure was improved through *Card Sorting* (see Section 5.1) and how the content and readability of the welcome page was enhanced (see Section 5.2). In Section 5.3 we reveal why users had problems filling out the special question types of the WISE survey and how we intend to solve the discovered issues.

5.1 Survey Logic and Structure

We used *Card Sorting* to determine the way that the new WISE survey should be structured. We already discussed in Chapter 4 that the previous question groups within the survey were not very organized. The survey logic diagram also improved our understanding of the relationships between the different survey parts. Nevertheless, we wanted to find out, how unbiased people, knowing nothing about WISE, would organize the survey content.

In Section 5.1.1 we explain how exactly we did the *Card Sorting*, and in Section 5.1.2 our findings and the new survey structure are presented.

5.1.1   Methodology

The *Card Sorting* techniques was created to facilitate the categorization of information, but in their book Spencer [2009] didn't mention any techniques to determine an order in which the information should be structured, nor did they include examples about how it could be applied to a survey. Therefore we adapted the technique to our needs. [Spencer, 2009]

We performed an open card sort with 4 people (3 males, 1 female) which were between 25 and 30 years old (P1-P4). Two of them were computer science students, one worked as a clinical trial coordinator, and one worked in the field of epidemiology. In this following chapter we will call them Card Sort participants or CS-Participant to make a distinction with the patient participants form Chapter 4.

We created one card for every question group. On the front of the card we wrote the question group title and if needed some additional explanations. On the back of the card (not part of the original card sorting) we glued the questions that were asked in this particular question group. We did this, because some question group included several screening questions, which made it very difficult to find a suitable card name. Using the back of the card allowed us to include additional information if needed.

Each *Card Sorting* sessions took around 90 minutes, and the exact process of these meetings is described in the card sorting protocoll (see Appendix A). In the meeting itself, we told every CS-participant he or she should first focus on the categorization of the cards and do any order- ing tasks afterwards. For the analysis of the data we then used the excel sheet that Spencer [2009] offered to do the analysis of the data. The analysis is available on the enclosed CD of this thesis (see Appendix D).

5.1.2   Result

The final result of the *Card Sorting* and the changes that were done to the original survey structure are displayed in Figure 5.1. The original ordering of the question groups is displayed on the right side, while the new order and categorization of the question groups is shown in the left column. The green and grey arrows show how the question

groups were reordered and the orange strikeout marks the question groups that were deleted entirely. One question group about *Final Remarks* was added at the end of the questionnaire (indicated by a green [NEW] sign).

The question groups were clustered into 6 categories: Personal Information, Chief Complaint, Other Complaints, Previous Treatments + Medication, Related Thoughts + Feelings, Closing + Feedback Questions. The question groups that every participant needs to answer, are written in bold. The display of all the other conditional questions are depending on the answers given in the survey.

The first category *Personal Information* inquires about very general information of the patients, which are not directly related to their complaints. All of the CS-participants of card sort have clustered these three question groups together. While they had also included questions about the *Habits* and *Mouth/Jaw related Habits* of the patient into this category, we decided to place these questions into the *Chief Compliant* group. We did this, because we noticed that the CS-participants found it difficult to put these two cards in any of the categories that they had defined. The fit with the *Chief Compliant* category was not ideal. The CS-participants also agreed that the questions about the chief complaint were the most important for the patients and that this question should be placed at the beginning. As experts we knew that the habits described in the questionnaires do have an influence on the chief complaint, therefore, we placed these two question groups at the end of the *Chief Complaints* category.

The second category *Chief Complaints* includes all the question groups that ask about specific aspects of the chief complaint of the patients. It starts with very general questions about the complaint itself, its onset, and diagnosis. The survey then moves on to a set of screening questions (*Symptom related disability*). Depending on the answers to these screening questions several other question groups would be triggered to inquire about specific parts of the chief complaint. At the end of this group, questions about complaint related habits were asked. We decided to not further divide this group, because CS-participants had the most problems to sort the questions that were related to the chief or other complaints. Most of the CS-participants initially put many cards about the chief complaint, pain, and other symptoms into one large pile and then tried to build sub clusters. But for this sub-clustering they then needed a lot of time and the resulting clusters differed a lot between the participants.

New Survey Logic

Personal Information

- **Patient characteristics**
- **Health insurance, referral and medical care**
- **Occupational status**

Chief Complaint

- **Chief complaint**
- **Modulating factors**
- **Onset of chief complaints**
- Duration of chief complaints
- **Diagnosis**
- **Symptom related disability – face / head**
- Impairment by tinnitus
- Migraine Screener
- **Symptom related disability – jaw / mouth**
- Jaw Function Questionnaire
- Problems with altered sensation or function
- Pain quality of chief complaint
- Pain drawing head
- Daily Pain Course of your Chief Complaint
- Temporal pattern of chief complaint
- **Habits**
- **Mouth / Jaw related habits**

Other Complaints

- **Disability by other pain**
- Pain drawing body
- Pain drawing torso
- Disability in daily activities
- **Other symptom related disabilities**

Previous Treatments + Medication

- **Treatments of the Chief Complaint**
- **Use of Medication**
- List of Medications

Related Thoughts + Feelings

- **Psychological condition**
- **Being a burden to others**
- Pain related fears
- Questions concerning mood disorders
- Questions concerning every day worries
- Questions concerning psycho-social stress
- Questions concerning impaired sleep
- Questions about injustice experience

Closing + Feedback Questions

- **Final Remarks [NEW]**
- **Privacy Protection**
- **Closing questions regarding your experience with this online survey**
- Closing questions regarding the video instructions
- Closing questions regarding the pain drawing
- Closing question regarding the diurnal course of pain
- Closing question regarding recording medication intake
- Recommendations

Original Survey Logic

- Patient characteristics
- Health insurance, referral and medical care
- Chief complaint
- **Symptom related disability – face / head**
- Impairment by tinnitus
- Migraine Screener
- **Symptom related disability – jaw / mouth**
- Jaw Function Questionnaire
- Problems with altered sensation or function
- **Parafunction**
- **Modulating factors**
- ~~Dysmorphophobia~~
- Pain quality
- Pain drawing head
- Diurnal pain course
- **Onset of chief complaints**
- Duration of chief complaints
- Time pattern
- **Disability by other pain**
- Pain drawing body
- Pain drawing torso
- Disability in daily activities
- **Other symptom related disabilities**
- Pain related fears
- **Psychological condition**
- **Habits**
- Questions concerning mood disorders
- Questions concerning every day worries
- Questions concerning psycho-social stress
- Questions concerning impaired sleep
- **Experienced injustize and being a burden to others**
- Questions about injustice experience
- ~~Questions concerning illness perception~~
- **Diagnosis**
- **Nonpharmalogical treatments**
- **Pharmalogical treatments**
- Other pharmalogical treatments
- **Occupational status**
- **Privacy Protection**
- **Closing questions regarding your experience with this online survey**
- Closing questions regarding the process of filling in this online survey
- Closing questions regarding the video instructions
- Closing questions regarding the pain drawing
- Closing question regarding the diurnal course of pain
- Closing question regarding recording medication intake
- Recommendations

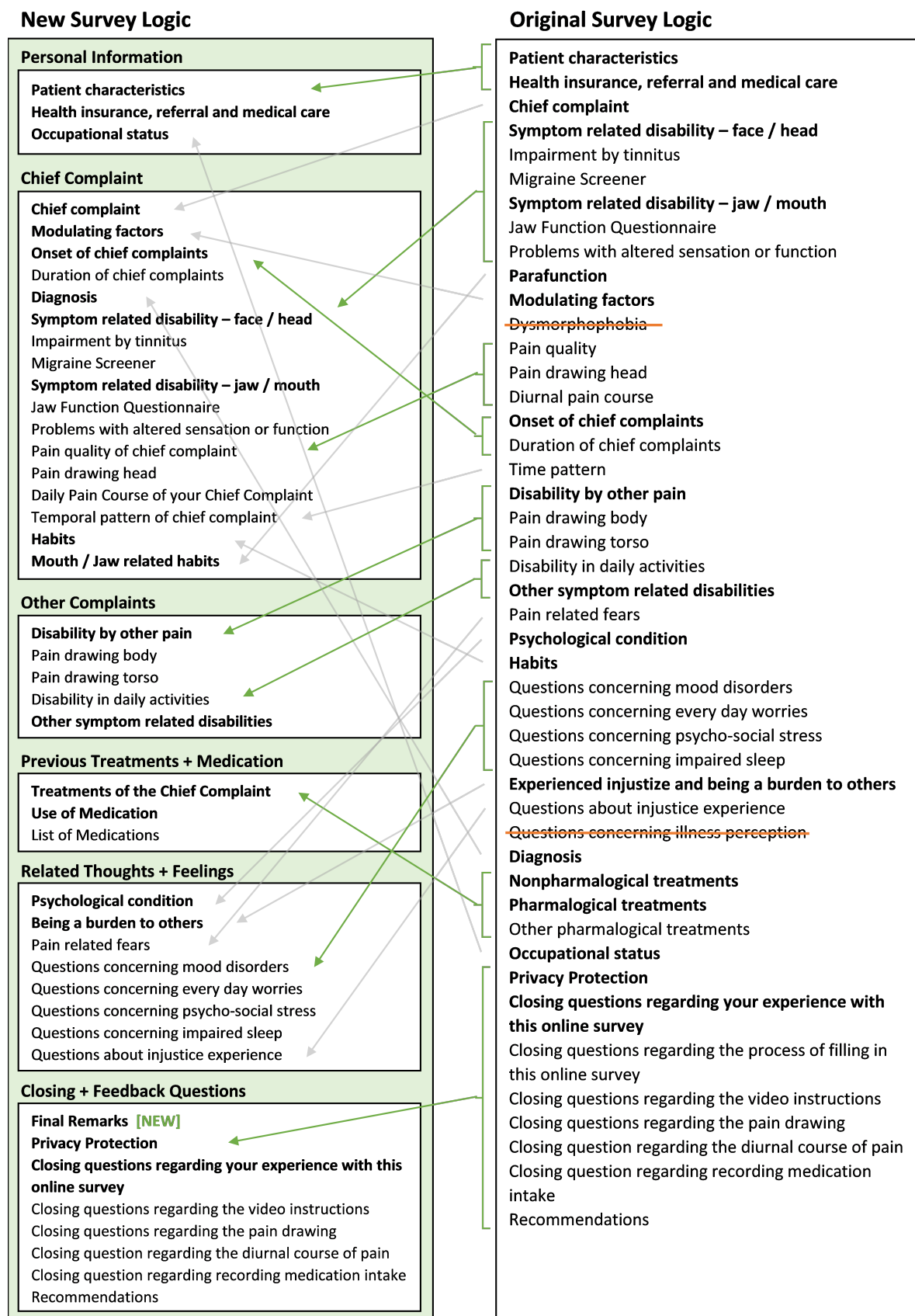**Figure 5.1:** Many question groups were moved as a bigger group (green arrows) or as a single topic (grey arrows); 2 were deleted (orange strikeout), and one was newly added (green [NEW]).

The third category *Other Complaints* includes questions about other complaints that the patients might have. This includes screening questions at the beginning (*Disability by other pain*), depending on these answers further questions about the related pain and disabilities were then asked. The last question group of this category (*Other symptom related disabilities*) inquired about different side effects (e.g. snoring, dizziness, worries, or stress) that could be related to the complaints. We could have also grouped these questions into the *Related Thoughts + Feelings* category. We decided not to do so, because Card Sort Participant 2 stated that these questions were more about facts (Do I snore? Yes/No; Do I worry? Yes/No) than the accompanying feeling or thoughts.

The fourth category *Previous Treatments + Medication* inquired about any kind of treatment that patients had or were still receiving. This includes questions about medical interventions, therapies, or medications of the patients. Clustering these question groups together was very intuitive for 4 of the 5 participants that did the card sort.

The fifth category *Related Thoughts + Feelings* includes all the questions that ask about different aspects that were related to the psychological condition of the patients. We named this category *Related Thoughts + Feelings*, because the practitioners of the orofacial pain unit suggested this naming. Until today many negative stereotypes and social stigmas that are associated with mental illnesses [Sue et al., 2015], therefore asking about feeling and thoughts seemed to be associated with less prejudgment. In the card sort, the classification of this group was also very homogeneous. These cards were grouped into one cluster very quickly by the participants. It was very interesting to see that one participant created two subgroups. One group of things that were easier to talk about (e.g. *Pain related fears*) and one with questions that were less easy to answer and for which a therapy could be needed (e.g. *Questions concerning mood disorders*).

The sixth and last category *Closing + Feedback Questions* included a final question to write down any other remarks, questions about privacy of the collected information (e.g. whether they could be used for research or not) and all optional questions for feedback about the survey itself. The CS-participants generally agreed that the feed- back questions should be placed at the very end of the questionnaire. Participant 4 mentioned that the privacy statement must be given at the start of a research study, but as the research is not the primary focus of this questionnaire, we found that it makes more sense to ask these

question at the very end. At this point, patients can assess whether they want to disclose their sensitive information for research purposes. Another CS-participant clustered the feedback questions about a specific question group (e.g. pain drawing) together with the question group itself, because then the participants would still remember if they experienced any issues while filling out these questions. While this is a valid concern, we decided to leave the feedback questions at the end because to the remaining 4 CS-participants this was more intuitive. To foster the recall of experienced problems, we will include an overview picture of the initial questions next to the feedback questions. With this overview picture we can compensate the temporal distance between asking and giving feedback.

Our main goal in reorganization and regrouping was to make filling out of the questionnaire more intuitive and simple.

5.2   Welcome Page

Both the user feedback evaluation and the survey logic inspection have revealed that the biggest weakness of the WISE survey is its length and complexity. The open-ended question analysis also revealed that some people criticized the missing overview of the questionnaire.

The following sections describe how we tried to address this problems by improving the welcome page of the WISE survey.

5.2.1   Methodology

To improve the initial welcome page of the WISE survey, we first created a Persona to represent the patients' needs and goals (see Figure 5.2). The persona was created based on our assumptions about the intentions, thoughts, and requirements that a patient of the orofacial pain unit might have towards the WISE survey. As we couldn't ask a real patient for feedback (for privacy reasons). Having the comments and issues from the user evaluation in mind, we did our best to put ourselves into the patients' shoes.

In a second step, we wrote down, what we wanted to accomplish with
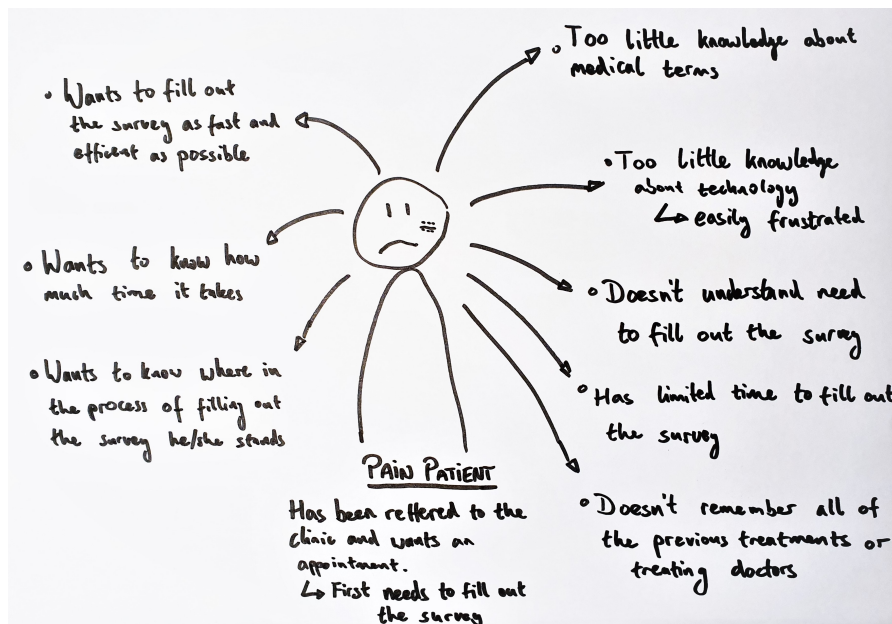
Figure 5.2: The image shows the pain patient persona, that was created based on our assumptions about orofacial pain patients.

this new welcome page. This list of goals was then used to define the content of the page. We then reviewed and improved the page based on the writing guidelines that we have found in research (see Section 2.2.4).

As a last step, the proposed solutions for the English and German welcome page were discussed with the practitioners from the orofacial pain unit and final versions were implemented into the WISE survey.

5.2.2   Result

The persona that was created to determine the focus of the survey welcome page is displayed in Figure 5.2. We assumed that the patient would want to fill out the survey as efficient as possible, because we know from the user feedback evaluation that the length of the survey was the most criticized thing. We also think that most users initially don't know why they must fill out this survey before they can arrange an appointment. Because the patients of the orofacial pain unit come from various backgrounds, we anticipated that they do not have much
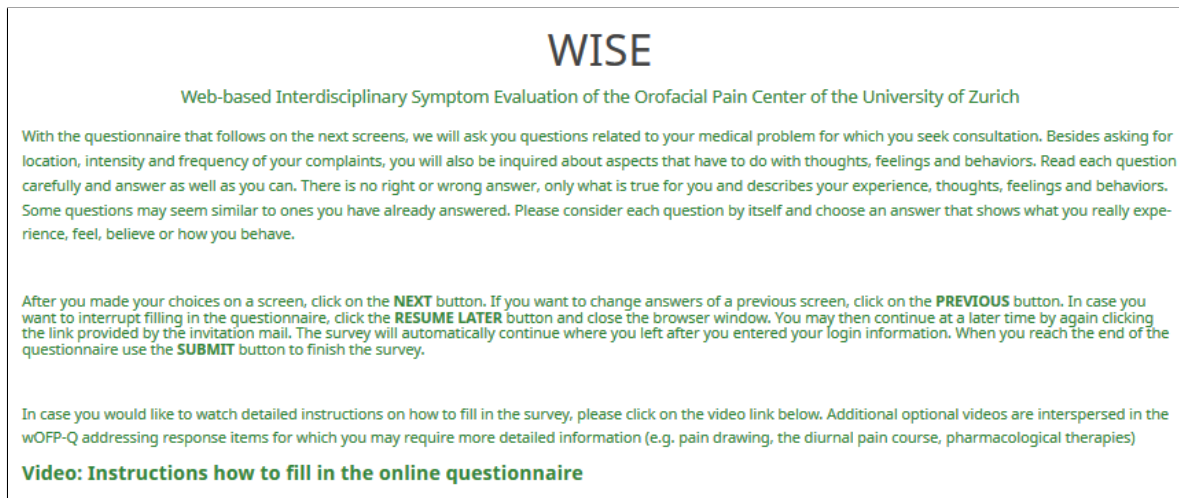
Figure 5.3: The old welcome page is entirely written in a green font.

knowledge about medical terms or technology. We further assumed that the exact name of previous treatment, names of previous health care providers or current medications were not clear for every participant.

Based on the finding from the user feedback evaluation (see Section 4.1) and the patient persona, we defined the goals of the welcome page as following:

- Motivate the users to diligently fill out the survey
- Inform the users why they have must fill out the survey
- Keep the survey short and brief
- Provide the crucial information needed to complete the survey
- Provide guidance for users who have little technological skills
- Give an overview of the topics that are covered by the survey

Appearance Changes. Figure 5.3 shows how the original WISE introduction page looked like and Figure 5.4 shows the new welcome page. The text of the old survey was entirely written in a green color, which made it quite hard to read because of the bad contrast to the background. We changed the regular text color to black and only left the paragraph titles in green. This made the larger text body easy to read and the title stand out. From the user feedback evaluation we know that the font was rather rated as too small than too large. So we increased the font size of the text from 12pt to 16pt.

Figure 5.4: The new welcome page is structured into four questions to improve page skimming.

Content and Structure.   The old version of the welcome page used 1/3 of the text to inform about the content of the survey and to give instructions that they should diligently fill out the survey. The remaining 2/3 of the text was used to describe how the users could navigate through the survey and to include a reference to an additional instruction video for further information.

To encourage the participants to properly fill out the survey we explained in the first section the benefits of this survey.

In the second paragraph, we wrote down a list of information that patients would be asked during the survey. The list contains items that patients probably would have to look up, like your insurance number, the address of the person that referred you to the clinic, information about previous treatments, and current medications taken. We included this list, because having all these information prepared could save a lot of time filling out the survey. It is more effective to prepare beforehand, than to interrupt the survey every time one of these questions appears.

The third paragraph included a short overview of the content. This list matches the new organization and grouping of the sur- vey logic (see Section 5.1.2). Many questions groups will only appear if certain conditions are met. Therefore, it is very difficult to indicate the progress of the survey completion. As a solution we decided to use these 6 question categories to visualize the progress within the survey. To highlight this concept, we included this content overview on the welcome page.

The last paragraph is a condensate form the instructions of the old survey. We decided to leave out the video instruction, because they covered the old survey logic. Renewing the videos is still subject of discussions as the realization is time consuming. In the questionnaire we highlighted the option to pause and resume the questionnaire with an image. The biggest drawback of the WISE survey is still its length, by highlighting the resume later option, we hope to give participants the option to take a break if they need to.

The very last sentence of the introduction reinforces the importance of the WISE survey by stressing that getting a consultation appointment is linked to finishing the questionnaire.

Easiness to Read and Skim. We subdivided the content of the welcome page down into four paragraphs to improve readability. Each paragraph started with a clearly distinguishable title. The wording of the titles should promote curiosity of the readers. Large text blocks were mostly replaced by bullet points. The wording of the bullet points focused on starting with the most important information.

We tried to keep the vocabulary of the welcome page as simple as possible and reduce any unnecessary words. We managed to include more information while using only 3 words more (old: 280 words; new: 283 words).

5.3 Questions with a special User Interface

In this section we will investigate the problems that users have experienced when filling out the questions with a special user interface. From the analysis of the open-ended questions (see Section 4.1.3) we know that participant encountered some problems filling out the questions of the pain drawings, diurnal pain course, or pharmalogical treatments.

In the card sort (see Section 5.1.2) our participants had difficulties to understand the meaning of the *diurnal pain course* and *pharmological treatments*. We therefore changed these question groups titles to *Daily Pain Course* and to List of Medications and will from now on use these names to refer to them.

Section 5.3 explains the methodology that we used to investigate and improve the special questions. The problems that were found and improved results are described in Sections 5.3.2–5.3.4.

5.3.1 Methodology

To investigate the problems of the different question types, we first conducted a user study with 3 participants (P1 - P3). The participants (2 female, 1 male) age was between 23 and 30. The participants included an epidemiologist, a medical student, and a psychology student.

FFor every question type the participants of the user study had to enter certain symptoms or edit their previous entries. The wording of the symptoms was kept vague on purpose, such that the participants had to first reflect about the answer before entering it. For example, we indicated the degree of pain in words (like *strong*, or *medium*) and not in numbers (e.g. 8, 4). This forced the participants to figure out a quantification themselves. The complete list with the task description of the user study is available in the Appendix C.

The problems found through the user study, were the basis for several improvement cycles. The human-centred design process was used to create and evaluate several prototypes to improve the special questions. We performed a total of three iterations to get the final prototypes that are described in the Sections 5.3.2–5.3.4. During the iterations we tested the prototypes with 3 different user (2 female, 1 male). The testers included a student, an employee and a retired person.

It is important to note that the LimeSurvey version of the WISE survey was updated just before we started to work on this thesis. Therefore the look and feel of the WISE survey had already improved a lot through this change. One huge benefit of the new LimeSurvey version is that the standardized questions are by default responsive.

5.3.2   Pain Drawings

The WISE survey includes three pain drawing questions to specify the pain that users felt on the head, body, and torso (see Figure 4.9 in Section 4.1.2). We used the pain drawing of the head to identify the problems and prototype a better solution for this question type.

Problems of the Pain Drawings

Figure 5.5 shows the pain drawing question from the updated LimeSurvey version. The user study revealed that the current pain drawing has four main problems.

Right and Left Indication is unintuitive.   P3 found that the wording of the question (*First, mark your view of the left and right side of the face by*
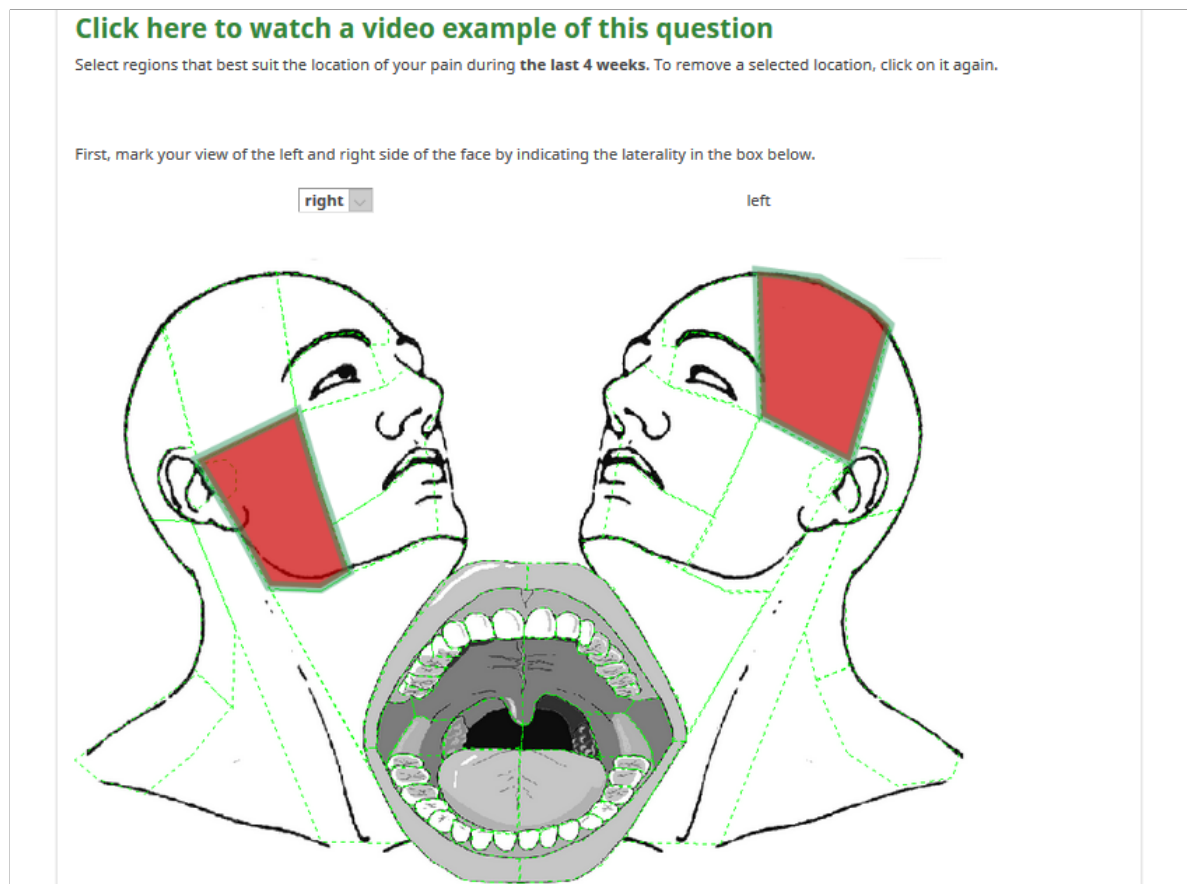
Figure 5.5: The updated pain drawing question has now a white background which provides better contrast to the text and the image.

indicating the laterality in the box below.) was difficult to comprehend. And P2 initially misunderstood the question completely and thought that she/he had to mark the face side on which she/he wanted to first input the pain. It was only later that P2 mentioned that the right and left sides were marked the wrong way around, but P2 never tried to correct this.

Pain Entries can't be edited.   All the participants were sur- prised to see that clicking on a previously entered pain area deleted this entry irreversibly. Instead of the deletion of the object, the participants would have expected that they could reopen the pop-up window and edit their entries, but this was not possible. To change a pain entry, you had to first delete it and then replace it with a new entry.

Changing Pain Default Values is Confusing.   To enter the pain intensity to an area, users had to first click on the area. Then they had to fill out two questions in a pop-up window, one about the pain intensity at rest and one on pain intensity during movement. The pop-up window stored the data from previous given answers. That meant that if a patient opened a second pain intensity pop-up window, the pain intensity value from the last entry would be already entered.. The default values for the pain intensity therefore would always be set to the last made entry. This feature was initially designed to save time, but confused P3 and P1. What was worse, P2 didn't even realize that the default values were not always reset to zero and made mistakes in the pain entries.

Adding a new Pain Entry can't be cancelled.   P3 realized that it was not possible to close the pop-up window by pressing the escape key without adding a new entry. The pop-up window itself provided no way to cancel the process or close the window. As P3 was often using the escape key, this was very irritating.

Improved Pain Drawings

To determine which side that patients perceived to be right or left, we decided to include one short question, that users needed to fill out before entering their pain into the drawing. We asked the users to click on the right ear of the image. Figure 5.6 shows the question including the answer that was given. The selected ear would be marked in read. An arrow with the label *"Your right ear"* would be displayed next to it, to help identification.

In the new pain drawing version, existing entries are editable. A click on previous entries triggers a pop-up window with the values that were previously specified. Entries can now only be deleted through this pop-up window (see Figure 5.7).

Knowing that the changing default values caused faulty entries (at least for some of the participants), we decided that the pain intensity of new entries would always have zeros on default.

We also included the display of tool tips that would show the entered pain intensity of an area when the mouse cursor rested on it (see Fig-
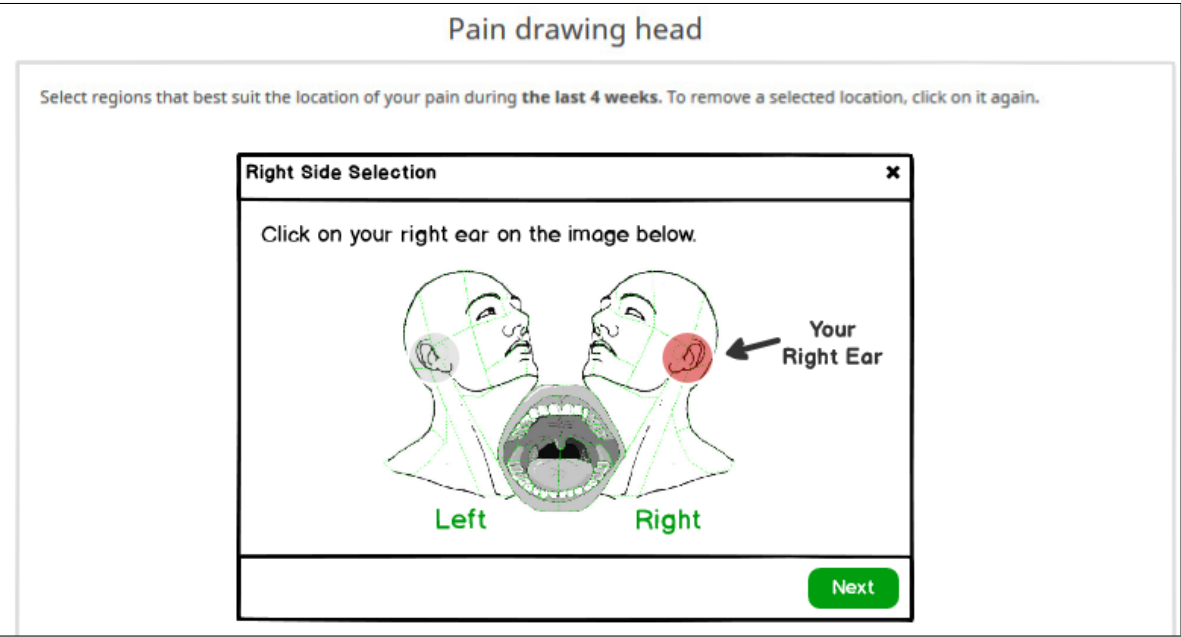
Figure 5.6: Before users can enter their pain into the pain drawing, they must determine where their right ear is located on the drawing.
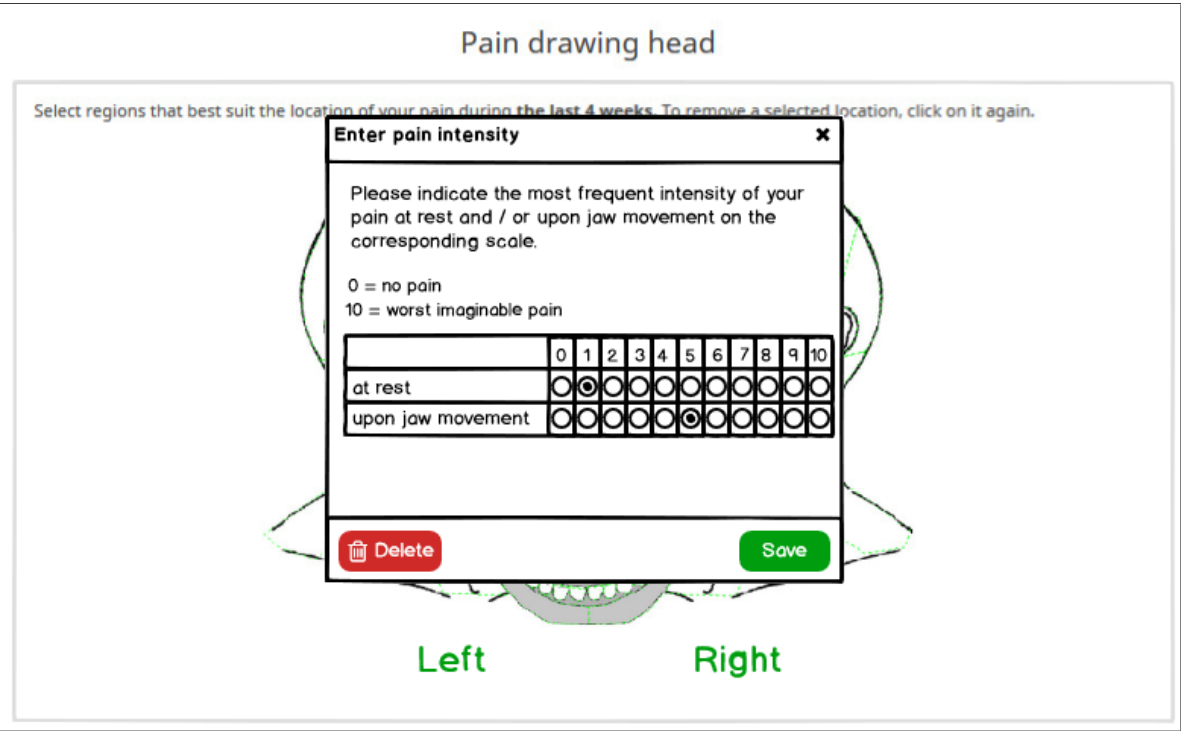
Figure 5.7: Pain intensity entries can now be edited.
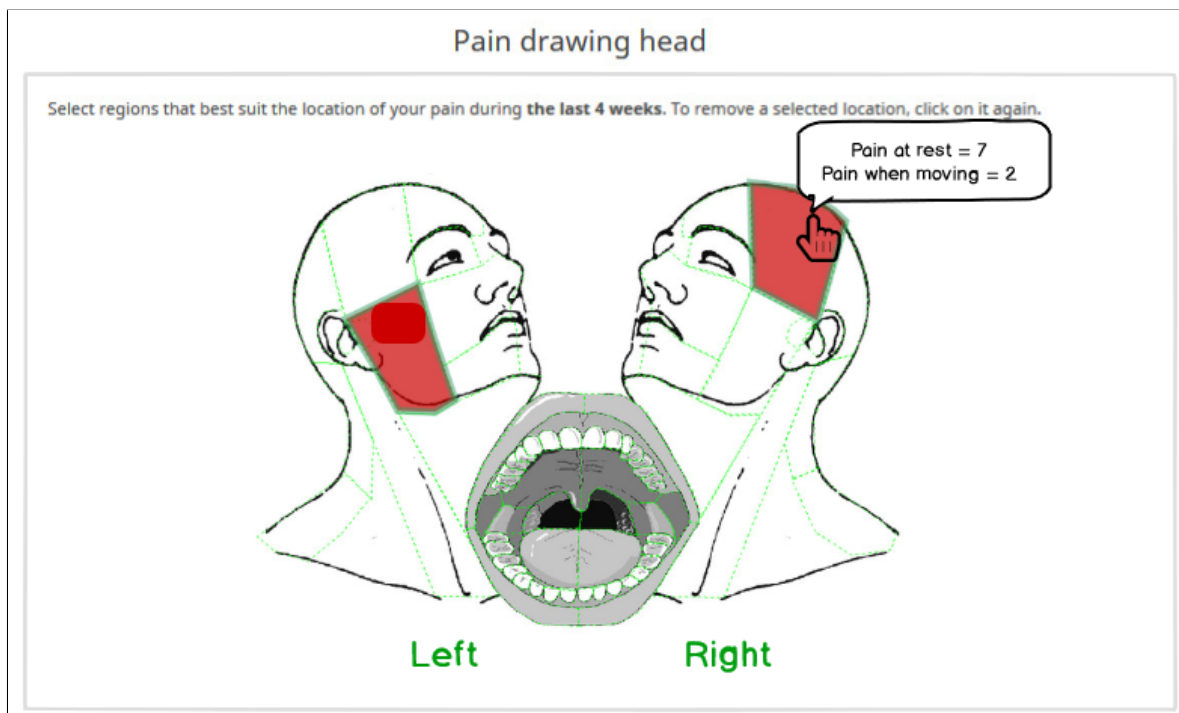
Figure 5.8: Tool tips were included to facilitate the comparison of the pain intensity of different areas.

ure 5.8). With this users can now easily compare their pain intensity entries.

5.3.3   Daily Pain Course

In the daily pain course question group, users were asked to indicate the average amount of pain that they felt during different time intervals of the day. Figure 5.9 shows how this question looked like on the new LimeSurvey version.

Problems of the Daily Pain Course

All participants thought that this question was very easy to fill out and edit. The comments they made were more about the understandability and graphical design of the question, than on the functionality itself.
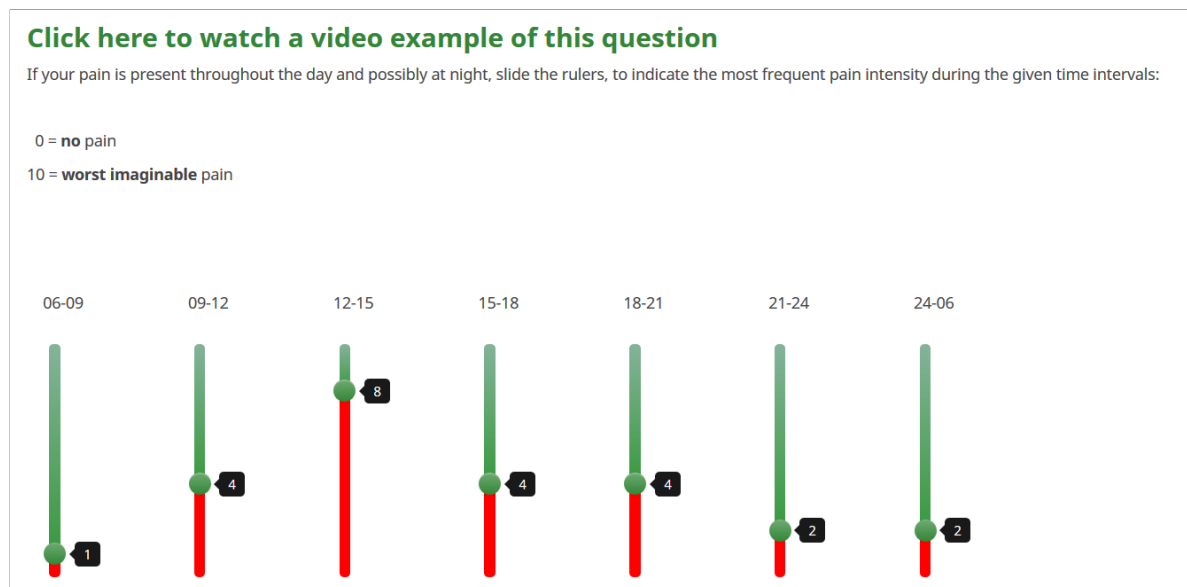
Figure 5.9: The slider of the updated daily pain course version is smaller and has a round handle to change its value.

Uncommon Time Labels.   It was not immediately clear that the question revolves around time. Two participants stated that they initially didn't relate the numbers (e.g. 12-15) on the page with time. They thought that the HH:MM time format (e.g. 12:00-15:00) would be more recognisable. P3 also stated that the time 24 does not exist and that it should be changed to 00:00 instead.

Inconsistent Time Intervals.   All time intervals but one were three hours long. Only the time interval during the night (from 00:00 to 06:00) included six hours. P1 mentioned that this was irritating. Some patients might also experience different amounts of pain during the night, which they couldn't indicate.

Colours of the Slider.   P2 liked the red color of the slider, because it signified the amount of pain well. But P2 found that the green color of the upper part of the slider was unnecessary, because the strong contrast didn't look so nice.
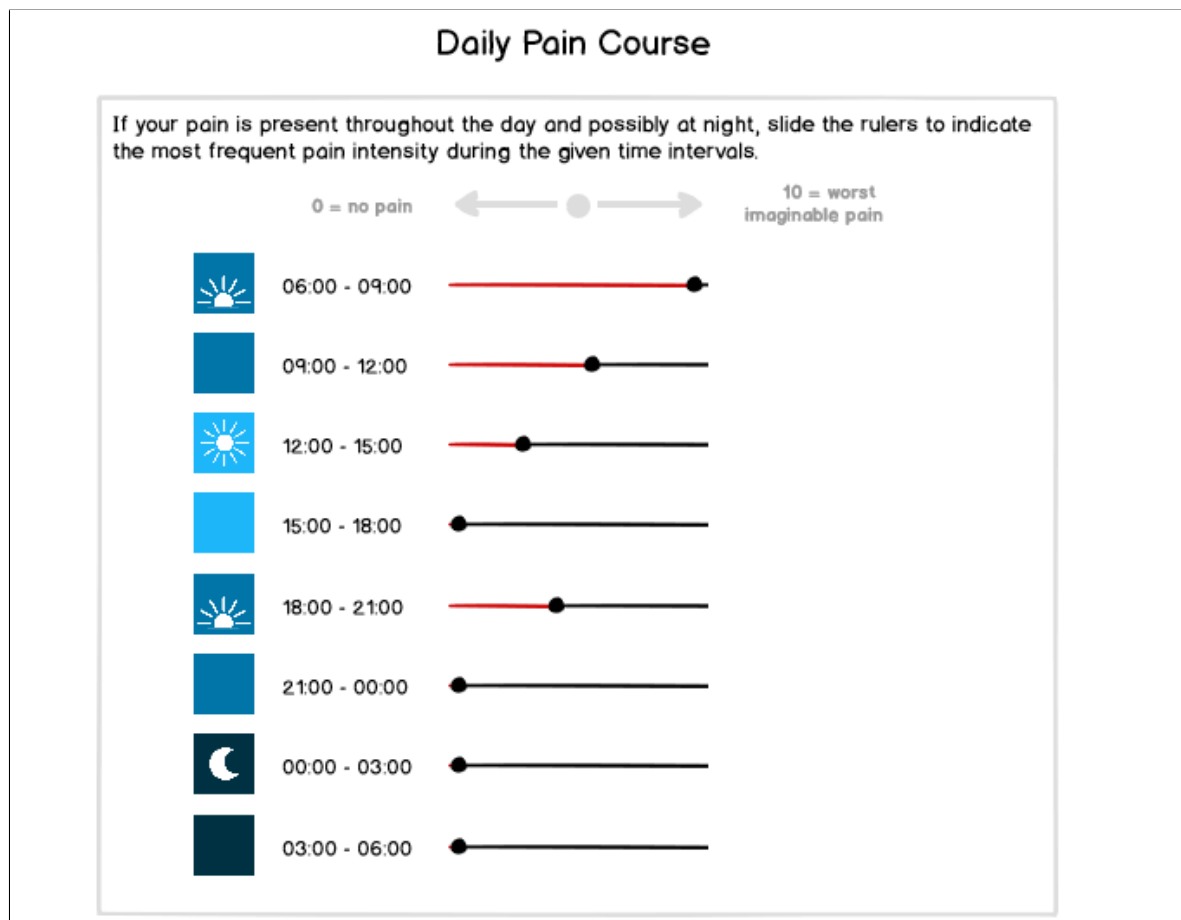
Figure 5.10: The new daily pain course includes 8 sliders, one for every three hours of the day.

Improved Daily Pain Course

Most changes made on the daily pain course focused on the graphical display. The time labels were changed to the HH:MM format. The six-hour time interval was split into two three-hour intervals. With this all sliders now refer to a time interval of three hours and the pain pattern during the night can also be assessed.

We changed the horizontal layout to a vertical one in support of smaller screen sizes. To emphasize that the question is about the daily pain pattern, small icons displaying the moon and different positions of the sun were added next to the time intervals (see Figure 5.10).

The pain intensity is still indicated with a red slider, we replaced the green counterpart with a neutral color.

5.3.4   List of Medications

In the old WISE survey patients had to enter their medication in two question groups. In the first question group (*Pharmalogical treatments*) they were asked to only record pain medication and in the second question group (*Other pharmalogical treatments*) they were asked to enter all other medications. We used the question from the *Other pharmological treatment* page, because it contained one additional question about the reason for taking medications (see Figure 5.11).

Problems regarding the List of Medications

The user study showed that this special question had some major usability problems. All three participants felt that filling out this question was very frustrating. Two of three participants had accidentally overwritten or deleted some of their medication entries. Not knowing what they did wrong, participants lost their trust into the system and became fearful of any other interactions.

Editing recorded Medication is cumbersome and error prone.   Most of the usability problems occurred when the participants tried to edit on of their previous medication entries. The interaction with the *Registered medication* list was error prone. Items could be opened very quickly, but if the user forgot to save properly, the entry would be lost. Some mistakes like the deletion or overwriting of an item could not be comprehended. Because one medication entry consists of several questions, losing one such entry meant that all the entered information was lost. The participants then needed additional time to reenter the whole medication item.

Inability to Delete Entries.   In the current WISE survey version, it's not possible to delete an entry that was already saved. The entry could be edited, but not removed. Even trying to leave all entries of the

Figure 5.11: The updated version of the List of Medications looks very similar to the old one, except that there is only one button to *save* the medication to the list.

form empty didn't work, because you couldn't save medications that contained empty elements.

Complicated Wordings. As a third issues P3 mentioned that some words in the form were very complicated. For example, *efficacious*, *rendering*, or *indication* are words that were medical jargon.

Improved List of Medications

To address the major usability problems that occurred when the participants tried to edit their previous entries, we restructured the page completely. To add a new medication to the medication list, users need to click on the *"Add Medication"* button (see Figure 5.12). Clicking on this button would then open a pop-up window in which the different medication related information can be recorded and saved (see Figure 5.13).

All the entered medications and related information are displayed as

Figure 5.12: With the new medication list, editing and deleting entries are simple tasks.

items on a list. Each item does have two buttons on its right side. One to edit the item, and the other to delete the entry (see Figure 5.12). A click on the delete button would trigger an alert pop-up which asks whether the user really wants to delete this entry. We decided to include this safeguard because the accidental deletion of such an item would mean considerable amount of additional effort to reenter the lost data.

We also simplified the wordings of the pop-up window questions (see Figure 5.13).

Figure 5.13: To enter a new medication to the list, users have to fill out the corresponding pop-up window.

Chapter 6

Conclusion

In the final chapter of this thesis, we will summarize what we have done and how we contributed to the improvement of WISE (see Section 6.1). In Section 6.2 we will discuss possible limitations of our results and to round it off, we'll explore directions to further improve WISE (see Section 6.3).

6.1 Summary and Contributions

As mentioned before the goal of this thesis was to improve the WISE system. This system digitally assesses the complaints of patients before the first visit of the orofacial pain clinic of the University of Zurich. The clinic developed and used the WISE system themselves. When we started this project, we had very little knowledge about the comprehensiveness and complexity of this system. Our initial goal was to explore and improve the *WISE survey* and the corresponding *Patient Summary Report*.

As we realized the complexity of the WISE survey, we quickly concluded that we need a deep inspection of the survey. This inspection enabled a base to implement changes and solutions of problems.

To discover possible problem areas of the survey, we first evaluated user feedback on the survey that was previously gathered. Parallel to this, we mapped out the logical survey structure to get a better under-

standing of the content of the WISE survey and the interconnections of its questions.

The main problems we found covered different parts of the survey. One of the main issues was the length and complexity of the survey. We have tried to address this problem by simplifying the language where possible, eliminating superfluous questions, and creating a well-structured welcome page that informed the patients about what to expect from the survey.

A second problem area were flaws of the survey logic and content. With a survey logic diagram we corrected all logical errors. The different pages (question groups) of the survey were reorganized based on the structure acquired by *Card Sorting*. We added several open questions to the survey to offer patients the possibility to describe unique characteristics of their complaints in their own words. This was important, because a standardized medical questionnaire will hardly ever covers all possible aspects of a patients complaint and medical history.

And as a last contribution, we investigated and improved several usability problems that were associated with tree special question types. From the user feedback analysis we knew that users of the WISE survey often encountered problems with the three pain drawing questions. Specially the question about the daily course of their pain, and the two questions where they had to enter their medications into the survey were cumbersome. We conducted a user study to investigate the usability problems. Based on the findings we prototyped, and user tested several solutions. We are now working on the implementation of these solutions into the survey.

6.2   Limitations

Probably the biggest limitation of our results is that we could not test our improvement with real patients of the orofacial pain center. While we tried our best to test our ideas with different people, it is possible that we have missed out to include some usability aspect that are very pain specific. However, we are confident that the various approaches used, allowed us to identify and address the most important problems.

Our lack of medical knowledge could be another source for faulty conclusions. We mitigated this risk through regular meetings and consultation with the experts from the orofacial pain center. All changes performed on the WISE survey were documented and larger alterations were previously discussed together.

6.3 Future Work

One thing that still needs to be finished, is the implementation of the solution to the usability problems of the special question types. We plan to complete this within the next couple of weeks.

As soon as the new version of the WISE survey is used to assess the complaints of the patients of the orofacial pain clinic, it would be very interesting to monitor the newly submitted feedback answers. By evaluating the feedback about the new survey version, we could determine whether our efforts were successful or not.

Improving the *Patient Summary Report* would be the next area that a continuation of this project would need to tackle. We already know that the patient report is used in different situations and by various people. Now it would be interesting to see, how different user groups (e.g. dentists, psychologists, assistants, or clinic administrators) make use of the information provided on the report. What information is most important for which user group and how could we modify the user interface to better fulfil these needs?

Another launched project is an attempt to use natural language processing tools to automatically evaluate the answers given in the open-ended questions. We are sure that there are many more application possibilities for computer science in the medical field.

Appendix A

Card Sorting Protocol

Card Sorting Protocol

0. Preparation

Prepare the following materials.

- Card Sorting Cards
- Extra (empty) Cards
- Pens
- Sticky Notes
- Rubber Band or Paper Clips
- Camera to take pictures
- Audio recorder

1. Introduce the activity

Pay attention to the following:

- Give enough background information that participants understand what the cards are about.
- Avoid leading participants to a particular result.
- Avoid long explanations.
- Steer people toward creating groups.
- Steer people away from designing the whole website.

"What This Is for"

I am currently redesigning the WISE questionnaire. This questionnaire was designed for patients with dental problems mostly related to pain in the head region. An important part of the project is to make sure that people are able to fill out this questionnaire in an efficient way that makes sense to them.

"We're Doing a Card Sort"

The activity we would like you to do is a "card sort"—we give you a bunch of index cards that show information of the survey, and you sort them. We can then look at how information could be organized and how other people think about information groupings.

"What You Have to Do"

The cards contain headings for types of questions that may be included on part of the survey. On the back of the card you will see some questions that are asked for this particular question group. Every patient that is referred to the clinic must fill out this questionnaire in order to describe their health problems. This information will then be used by the doctors to prepare the first appointment.

I would like you to sort the index cards into groups of cards that, to you, belong together. You may like to think about this information:

- What content would you like to see close together when filling out the survey?
- Are some questions/topics related to one another?
- What content or questions are clearly not related to each other?
- If you were a patient filling out the questionnaire, which questions groups would you like to fill out in quick succession?
- What cards just seem to belong together?

There is no right or wrong way to group the cards.

If you have this situation:
- Cards that don't fit with anything, then leave them out.
- A card that you would like to put in two places, then write its name on a spare card and put it in both places.
- A large group, then see if you need to break it into smaller subgroups.
- Lots of small groups, then see if you can group them into a larger group.

Please let me know about your thoughts and reasonings by speaking out loud what you are thinking.

Is it okay for you, if I audio record this session? May I start the recording now?

"What Happens Next"
I look at the different ways that people group the cards. This helps me to see which topics clearly belong together and which ones don't. We also look at the way people describe their groups, and this helps us to create labels (such as for navigation) within the questionnaire.

Any open questions? Feel free to ask during the sorting!

2. Hand out the materials
Spread out the cards in a random way on the table. Give them the empty cards and a pen, to write on them.

3. Participant sorts the cards
Observe the card sorting. Note down:
- Which cards are put together first (and stay together) → straightforward natural groups
- Which cards are left until the end → content that doesn't fit into groups as easily
- Interesting spatial groupings → Take a photo of interesting groupings

4. Participant labels the cards
When the participant seems to settle on a set of groups, ask him/her to give the different groups a label and to write down a reason why they belong together.

"When you have finished grouping the cards, place a sticky note on top and describe why you have put them together—a few words are enough. Bundle the groups with elastic bands so we can tell which cards go together."

5. Ask follow-up questions / Debriefing
Ask follow-up questions:
- What was the rationale to group the cards into this groups?
- For each of the groups, which cards do you think does represent the group best? And which cards are less representative?
- Are you happy with the overall outcome of the sort?
- Which activities did you find easy to do? Which cards were easy to sort/group?
- Which activities were difficult to do? Which cards were difficult to sort/group?

6. Record outcome
- Stop recording
- Write the card numbers of each group on the corresponding label sticky note.
- Take a picture of the groupings.

Appendix B

WISE Contextual Model

Register new Pain Patient
(Sequence Model)

	Referential Doctor	Triage Post	Clinic Administrator (CA)	WISE System	Clinic Administrator (CA)	Patient	Lime Survey
Actor							
Trigger	Has a patient which needs dental treatment	Distinguish between dental and pain patients.	Clinic Admin receives pain patient referral letter	New patient needs to be added to the WISE system	Clinic Admin wants to invite the new patient to the clinic	Receive letter with logging information for the survey	Patient completes & submits the survey
Actions	Send a referral letter to the dentist clinic	Every referred patient is checked and only patients with a pain issue are considered for this process	CA enters patient data into CIS	WISE generates token (15 digits) (3)	CA accesses the generated patient invitation letter in WISE	Logg in to WISE	LimeSurvey triggers WISE to update the information about the survey completion
			CA records patient information into VitoDent	WISE adds same token to LimeSurvey (3)	CA sends the invitation letter to the patient	WISE checks user credentials	
			CA records patient information into Access DB	WISE creates a username & a password for the new patient (4)		WISE checks if patient has already filled out the survey (2)	
			CA enters patient data into WISE (1)	WISE generates a generic letter for the patient with the loggin credentials (5)		WISE directs patient to the survey on LimeSurvey (6)	
			Access automatically generates a button with an URL pointing to WISE (1)			Fill out the survey & submit it	
			CA clicks on the button to access WISE				
			CA logs in to WISE with private username & password (2)				
			WISE checks user credentials				
			CA approves that a new patient is added to WISE				

Legend:
Person □   *System* ⬚
General ■   *ZZM Specific* ■

Schedule & prepare Pain Patient Appointment
(Sequence Model)

Actor

Trigger

Actions

CRON

Every day at a pre-specified time

Checks WISE for new survey entries

Sends mail with a summary of the new entries to the CM

Team Member (TM)

Receive notification email about new survey submissions

TM looks at the survey summaries of the new patients

TM records survey return information into Access DB

TM schedules an appointment for the patient

Decide if the patient only needs an appointment with the dentist or also with the psychologist

TM forwards notification with decision to CA

Clinic Administrator (CA)

Receive notification with appointment decision

Schedule appointment(s) in VitoDent

Clinician

Learns about new patient assignment

Look up patients ID in the CIS

Look up the patient ID in the access DB

Click on the button that opens the patients WISE page

Logg in to WISE

Look at the summary report of the patient (7)

General
ZZM Specific

Person
System

Additional Information

① HTTP GET URL

Built out of the following components:
- CenterID
- PatientID
- Language

e.g. CenterID: *00001*, PatientID: *110015*, Language: *Deutsch*

https://www.mysymptomlist.com/index.php?lang=de&pa-rams=110015,00001

② CA loggin credentials:

Username: „*sarp*"
Password: „*sarpPW*"

③ Limesurvey Token:
Automatically generated by WISE

e.g. *bf285d59f2c130d*

④ username:
Combination of CenterID & PatientID
CenterID: *00001*
PatientID: *110015*
→„*00001-110015*"

password:
Automatically generated (10 characters)
e.g. „*FKJiWUyq?j*"

⑤ Patient loggin credentials:
URL: „*www.mysymptomlist.com*"
Username: „*00001-110015*"
Password: „*FKJiWUyq?j*"

⑥ One example Question in LimeSurvey.

Diurnal pain course

Indicate with the rulers the most frequent pain intensity during the given time intervals:

0 = **no pain**
10 = **worst imaginable** pain

06-09	09-12	12-15	15-18	18-21	21-24	24-06
2	3	5	4	3	2	1

⑦ Summary Overview of WISE

Single Case Summary Report: 2016-02-25 / ZZM
ID: mR*Oh2a1fm

Gender: male, **Age:** 48, **Height:** 187, **Weight:** 102, **BMI:** 29
Occupation: dentist 100%
Referred by: self-referral
Primary M.D.:

Habits: pastsmoker; stopped 4yrs ago / **does not drink alcohol daily**

Chief complaints

Chief complaint: headache
Main impairment: work interference
Expectations: less pain
Modulating factors: *aggravating:* none
alleviating: rest, holidays

Parafunctions
Tooth grinding / Tooth pressing	2/2
Tongue thrusting	1/2

Pain quality
at onset :
now: dull - pressing, exhausting, burning - hot, shooting - electric,
Pain intensity: most frequent **4**, maximum **4**,tolerable **1**

Time pattern

Pain duration: more than 5 years
Pain onset: gradual

Characteristic daily pain pattern

Impairment (Checklist)

Impairment face / head
Toothache / oral pain (e.g. tongue, gums ...	1/2
Pain / tightness in the jaw or face ...	2/2
Ear pain, Ear pressure, Tinnitus, ...	2/2
Headache	2/2

Impairment jaw
Limitation / pain upon mouth opening or ...	1/2
Limitation / pain upon biting / chewing ...	1/2
Clicking, Crepitus,	
Tooth / jaw position (e.g. bite is incor ...	2/2
Dry mouth / malodor / swallowing difficu ...	1/2

Other impairment

Worries about my chief complaint(s) ...	1/2
Increased fatigue / loss of energy / unintentional ...	2/2
Snoring / apnea during sleep	1/2
Lack of time / work related stress / caring respon ...	2/2
Lack of support / interpersonal conflicts / loneli ...	1/2
Different opinions of different care givers / not ...	1/2

Assessments

Additional questionnaires

	Score
① Pain Catastrophizing Questionnaire	22/39
① Migraine Screener	1/3
① Tinnitus Handicap Inventory	19/36
① Insomnia Severity Index	9/28
① GAD7 Generalized Anxiety Disorder	12/21
① PHQ9 Depression	13/27

Previous diagnostics and treatment

Diagnostic
Examinations: none
Diagnosis: none

Treatment efficacy
① occlusal splint 7/10

Pain medication efficacy
paracetamol 500mg since: 1/2 year, 2 x / w 7/10

Consent

Medical information can be exchanged:	YES
Data can be used for research:	NO
Would like to be informed about results:	YES

Alternative Line of Action

Clinic Administrator (CA)

CA enters patient data into WISE

[Patient does NOT exist] → Accept that new patient is added to WISE

[Patient exists]

[No filled out survey] → Inivite patient to fill out the survey

[Filled out survey]

[Access results] → Inspect existing survey summary/ results

[Create new] → Open a new survey for the patient to fill out

WISE System

WISE checks if patient has already filled out the survey

[Survey is not filled out] → Display survey to be filled out

[Partially filled out survey] → Display started survey page where the patient had left

[Survey is filled out] → Display summary overview

Appendix C

User Evaluation Task

User Task Description

Task 1 – Pain Drawing Head

1) Enter the following pain into the drawing:
   a. You have a lot of pain in your left jaw joint when you eat or yawn. At rest it usually feels much better and you only feel a little twinge.
   b. In addition, you suffer from constant ear pain on the right side. The pain feels rather dull, like experiencing strong pressure on the ear when you quickly move down a mountain. But you can't equalize the pressure and it is always there.
   c. At lunch you bit on the right part of your lip quite strongly and you still feel the pain. Compared to the ear pain, you think that the lip currently hurts more.

2) You realized that you made some mistakes
   a. While the pain in the lip currently hurts quite a lot, you realize that this is not part of the complaint and reason why you contacted the dentist clinic and it will probably go away quickly. Therefore, you decide to delete this entry.
   b. While studying the pain drawing, you realize that the ear and jaw pain are located on the same side of your face – the left one. Correct the entries accordingly.

Additional questions:
- How satisfied are you with the result of your pain drawing?
- What difficulties did you experience when filling the pain into the drawing?
- What did you find confusing?
- Do you think your pain is properly displayed on the drawing? Why? Why not?

Task 2 – Diurnal pain course

1) Enter the following pain problems into the drawing:
   a. Your jaw joint pain is usually the worst during the time after lunch. Then the joint hurts a lot.
   b. Luckily during the nighttime, the pain is usually less strong, such that you have no trouble sleeping.
   c. Otherwise the pain is on a medium level throughout the day.

2) You realized you made some mistake:
   a. You realized that your pain is least strong in the morning, after getting up. There you feel almost no pain. You change your entries accordingly.

Additional questions:
- How satisfied are you with the result of your pain drawing?
- What difficulties did you experience when filling the pain into the drawing?
- What did you find confusing?
- Do you think your pain is properly displayed on the drawing? Why? Why not?

Task 3 – Pharmacological Treatments

1) You take the following medications enter their data into the survey:
   a. You take Aspirin with 500mg acetylsalicylic acid when you suffer from a headache which happens roughly once a week. After a half an hour the headache is usually gone or only weakly present. You can't remember when you took your first Aspirin, but you know that since about two years your headaches started. Since then you have to take Aspirin regularly.
   b. You're doing quite a lot of sport (about 4 times a week) and oftentimes have aching knees afterwards. In this case you'll usually take a Voltaren Dolo forte (25 mg) tablet. The pain then goes away, so the medication works very well. You started to take Voltaren about a half a year ago.
   c. Since April you know that your blood pressure is too high and you take Beloc-Zok mite (47.5 mg) tablets against it. You must take one tablet in the morning every day. In the control examination your blood pressure went slightly down.
2) You realized that you made a mistake:
   a. You realized that your knee problems got better and that you are only taking about 2 tablets a week. Change this entry accordingly.
   b. After short reflection you decided to delete the entry about your Aspirin intake. Change this entry accordingly.

Additional questions:
- How satisfied are you with the result of your medication recording?
- How easy/difficult was the recording of the medications?
- What difficulties did you experience when filling in the medications?
- What did you find confusing?

Appendix D

CD Content

- English Abstract
  Abstract.txt

- German Abstract
  Zusfsg.txt

- Sequence Model of Patient Registration Process
  WISESequenceModel.pdf, WISESequenceModel.ai

- Finding of the Survey Logic Inspection
  SurveyLogicIssues.pdf

- Card Sorting Protocol
  CardSortingProtocol.pdf

- Card Sorting Analysis
  CardSortingAnalysis.xls

- User Evaluation Task
  UserEvaluationTask.pdf

- Pain Drawing Prototype
  PrototypePainDrawing.pdf

- Daily Pain Course Prototype
  PrototypeDailyPainCourse.pdf

- List of Medications Prototype
  PrototypeListOfMedications.pdf

Bibliography

Yen-ning Chang, Youn-kyung Lim, and Erik Stolterman. Personas: from theory to practices. In *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*, pages 439–442. ACM, 2008.

Wikipedia contributors. Orofacial pain, 2019a. URL `https://en.wikipedia.org/wiki/Orofacial_pain`. [Online; accessed 20-November-2019].

Wikipedia contributors. Proper right and proper left, 2019b. URL `https://en.wikipedia.org/wiki/Proper_right_and_proper_left`. [Online; accessed 7-November-2019].

Alan Cooper et al. *The inmates are running the asylum:Why high-tech products drive us crazy and how to restore the sanity*, volume 2. Sams Indianapolis, IN, 2004.

Angela Liegey Dougall, Carmen A Jimenez, Robbie A Haggard, Anna W Stowell, Richard R Riggs, and Robert J Gatchel. Biopsychosocial factors associated with the subcategories of acute temporomandibular joint disorders. *Journal of orofacial pain*, 26(1):7, 2012.

Samuel F Dworkin, Jeffrey Sherman, Lloyd Mancl, Richard Ohrbach, Linda LeResche, Edmond Truelove, et al. Reliability, validity, and clinical utility of the research diagnostic criteria for temporomandibular disorders axis ii scales: depression, non-specific physical symptoms, and graded chronic pain. *Journal of orofacial pain*, 16 (3):207–220, 2002.

Chris Eccleston. Role of psychology in pain management. *British journal of anaesthesia*, 87(1):144–152, 2001.

Dominik A Ettlin, Isabelle Sommer, Ben Brönnimann, Sergio Maffioletti, Jörg Scheidt, Mei-Yin Hou, Nenad Lukic, and Beat Steiger.

Design, construction, and technical implementation of a web-based interdisciplinary symptom evaluation (wise)-a heuristic proposal for orofacial pain and temporomandibular disorders. *The journal of headache and pain*, 17(1):77, 2016.

Herta Flor, Niels Birbaumer, and Dennis C Turk. The psychobiology of chronic pain. *Advances in Behaviour Research and Therapy*, 12(2): 47–84, 1990.

Floyd J Fowler Jr and Floyd J Fowler. *Improving survey questions: Design and evaluation*. Sage, 1995.

Karen Holtzblatt, Jessamyn Burns Wendell, and Shelley Wood. *Rapid contextual design: a how-to guide to key techniques for user-centered design*. Elsevier, 2004.

Samantha Jaroszewski, Danielle Lottridge, Oliver L Haimson, and Katie Quehl. Genderfluid or attack helicopter: Responsible hci research practice with non-binary gender variation in online communities. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, page 307. ACM, 2018.

Jeff Johnson. *Designing with the mind in mind: simple guide to understanding user interface design guidelines*. Elsevier, 2013.

Os Keyes. The misgendering machines: Trans/hci implications of automatic gender recognition. *Proceedings of the ACM on Human-Computer Interaction*, 2(CSCW):88, 2018.

Linda Newman Lior. *Writing for interaction: crafting the information experience for web and software apps*. Newnes, 2013.

Donald R Nixdorf, MT Drangsholt, Dominik A Ettlin, C Gaul, R De Leeuw, P Svensson, JM Zakrzewska, Antoon De Laat, and W Ceusters. Classifying orofacial pains: a new proposal of taxonomy based on ontology. *Journal of oral rehabilitation*, 39(3):161–169, 2012.

Don Norman. *The Design of everyday Things: Revised and expanded edition*. Basic Books, 2013.

Jeffrey P Okeson. The classification of orofacial pains. *Oral and maxillofacial surgery clinics of North America*, 20(2):133–144, 2008.

Kara Pernice. Affinity diagramming for collaboratively sorting ux findings and design ideas, 2018. URL `https://www.nngroup.com/articles/affinity-diagram/`. [Online; accessed 18-November-2019].

Donna Spencer. *Card sorting: Designing usable categories*. Rosenfeld Media, 2009.

Mayo Clinic Staff. Tmj disorders, 2018. URL `https://www.mayoclinic.org/diseases-conditions/tmj/symptoms-causes/syc-20350941`. [Online; accessed 20-November-2019].

David Sue, Derald Wing Sue, Stanley Sue, and Diane M Sue. *Understanding abnormal behavior*. Cengage Learning, 2015.

Rolf-Detlef Treede, Winfried Rief, Antonia Barke, Qasim Aziz, Michael I Bennett, Rafael Benoliel, Milton Cohen, Stefan Evers, Nanna B Finnerup, Michael B First, et al. A classification of chronic pain for icd-11. *Pain*, 156(6):1003, 2015.