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Dual Process Theory as a framing heuristic for user cognition, amongst novice designers

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P10

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ABSTRACT

For the present thesis project I attempt to highlight a growing problem of *novice* designers with no knowledge of *usability* partaking in, or even being responsible of, design projects. I argue that a viable approach towards addressing this problem is to help make knowledge of cognitive science and user cognition more understandable and applicable to novice designers through *heuristics*, i.e. design guidelines. In particular, using a meta-theoretical framework called Dual Process Theory (DPT), which makes an overall distinction between two types of cognitive processes, I see potential in framing the heuristics through the '*fast*' and '*slow*' thinking metaphor of DPT. This leads to the Problem Statement of the thesis project: "*In which ways can Dual Process Theory operationalise as a framing heuristic for user cognition amongst novice designers, during concept creation and evaluation?*".

I attempt to approach this Problem Statement by first (*1*) conducting a theoretical exploration of the (*i*) key (*ii*) cognitive process that (*i*) Dual Process Theory (DPT) can help communicate. This was done with (*iv*) a preceding conceptual analysis of DPT as a meta-theoretical framework. From that (*2*) I opted to explore design-research pertaining information of *how* to go about designing a set of heuristics for helping novice designers design with usability in mind. These heuristics try to communicate easily understandable and applicable knowledge about user cognition and give general, sound advise based on that knowledge. I subsequently (*3*) went through a *creative process* towards the development of a prototype of the heuristics. I (*4*) tested the prototype of the heuristics with a *validity check*, concerning how they communicate cognitive science research, through DPT, in a scientifically valid manner. Proceeding from there, I (*5*) gained *expert practitioners input* on applying the heuristics through a focus group. From the insights of this, (*6*) I created my final research design for a *Main Study* with *seven novice designer participants*. They were all individually interviewed for their experience applying the heuristics in an Activity that enacted as a case context.
Dual Process Theory was found found show great promise as a framing heuristic of user cognition by providing (*a*) a unified, *general* understanding of user cognition and cognitive science. By applying the *fast* and *slow* thinking metaphor DPT can provide a reductionist language that enables novice designers to more easily express, or put into words, knowledge of user cognition. It provides a lens to see specific information about user cognition through.
Lastly, the DPT-framed set of heuristics, or guidelines, conveying user cognition knowledge were found to mainly enact as either a (*b*) *framework* for concept '*creation*', helping novice designers avoid cognitive fixation during the ideation process. Or, the heuristics could have the opposite effect, (*c*) disrupting an otherwise existing *flow* of ideation. For concept '*evaluation*' the novice designer participants universally found great value in adopting the heuristics as a 'checklist'. This helped the participants with a difficulty typical of novice designers, which is the lacking ability to conduct preliminary evaluations of concepts, based on criteria outside of personal preferences.

Reading guide

The process of writing this thesis has not been without bumps. A lengthy sick leave has prolonged the process, and as such much of work going into the project has been part-time for the majority of the duration writing. It is likely that these circumstances have altered the outcome of the thesis into something else than if it had been written over a four month period. Mainly, the thesis is long. In going back and forth between writing and resting, I found that the most realistic way to complete the learning goals for the project was to carefully outline each step of the process, as way of guiding the reader and myself included. This has resulted in a project more lengthy than usual.

For more easily approaching the bodies of work, I suggest to take a look at the outlining of the project, in Section 1.6 as well as read the conclusion in Section 6.4.
That aside, I hope you will find the research of interest, and that I can help spark future conversations. For any questions or concerns, please feel free to reach out.

Acknowledgements

This thesis, this thesis in particular, would not have been possible without the loving support of friends and family. I felt an overwhelming sense of care being given in aiding me towards the hand-in.
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Section 1

In this Section 1 you, the reader, will get introduced to the premise and focus of the project.

Here, I first identify the issue that there are (*i*) a growing number of *novice* designers engaging in user-centered design without designing with *usability* in mind. This is problematic because it can lead to numerous design projects suffering from poor usability. I then go to argue that (*ii*) a viable direction for addressing this problem could be to turn towards cognitive science. Much of the knowledge that could help these novice practitioners comes from cognitive science, but it is by itself inaccessible and difficult to immediately apply.
I then present the intent of the thesis which is (*iii*) to develop a tool to help the novice designers design with usability in mind. The tool, which is a set of *heuristics*, i.e. a set of guidelines with readily accessible information to guide-problem-solving, will be created around the hypothesis that user cognition can be made more immediately understandable and applicable when communicated through the *Dual Process Theory* (*DPT*) meta-theoretic framework. This amounts to the Problem Statement of the thesis project.

At the end of this Section 1, you will also see an overview of the remaining thesis project, detailing its intended structure. And, there will be a preview of the developed heuristic tool to help provide a sense of what the project will amount to.

1.1 The identification of a problem

In the field of design, few paradigm shifts have been as substantial and lasting as the adoption of the *user-centered approach*. Across subfields, such as service design or industrial design, the user-centered approach to design helps practitioners emphasise (*i*) an early focus and establishment of users' needs in the given design scenario, (*ii*) empirical measurements of whether those user needs are met, and (*iii*) an iterative process where the design is bettered through the measurement findings (Rogers, Sharp, & Preece, 2011, pp. 326-329).
There are several ways to go about establishing user needs, but broadly speaking those needs can be divided into (*i*) what problem a design should help the user solve, (*ii*) what functionalities of the design will most appropriately help solve that identified problem (i.e. the *utility*), and (*iii*) third *how* the design should go about best serving the user during the use of its functionalities (i.e. the *usability*).
More often than not, users of products and services have a need for understanding their possibilities for interaction, and have those interactions be straightforward and intuitive, all the while requiring little mental effort. These needs are essentially needs of *usability*, a quality attribute for the ease-of-use of product or service (Juristo, Moreno & Sanchez-Segura, 2007), and they are to a great extent transcending across *what* problem a product or service should solve with its functionalities. In other words, the need for a design of high usability tends to be universal, regardless of the defined problem or intended utility (e.g. Shneiderman, 2000). Additionally, designing with usability in mind has proven both cost-effective and beneficial to business, when taking into consideration its positive effect on increasing user adoption, minimising unacceptable and costly errors, while shortening the product or service development time (Donahue, 2001).

1.1.1 Usability being in a staffing crisis

With usability being a crucial aspect for user-centered design projects in general, it seems logical that those responsible for the design process have to be both aware and capable of designing with usability in mind. This poses an essential dilemma, because user-centered design has increasingly gone from being performed by a select few expert practitioners onto becoming democratised to great and diverse groups of practitioners (Manzini, 2015; Mau, 2004). This spread has, to an extent, been accelerated by the popularisation of enticing frameworks such as *design thinking* (Dorst, 2001). In some scenarios, those partaking in, or even those responsible of, the design process are not skilled design practitioners, which can become problematic for the success of those projects (Manzini, 2009, p. 7). Nielsen

(2005) addresses this problem in his piece *Usability for the Masses*. He states: "*Currently, the main solution to the lack of usability staff is to have almost all design projects proceed without usability. The vast majority of user interface design decisions in the world are made based on the designer's personal taste.*" (Nielsen, 2005, p. 2). In attempting to provide possible solutions to this problem, he outlines two different approaches. The first could be "*…to continue the reliance on traditional usability methods and scale up the number of usability professionals.*" (p. 2.). However, with the sheer amount of design projects needing usability expertise this may be the less impactful proposal of the two. Instead, Nielsen proposes "*…to expand usability beyond the usability professionals. If everybody needs usability, then everybody should do usability. We may need 50 million people who know some usability, but I think that is easier to achieve than getting one million people who are full-time usability experts.*" (p. 3).

1.1.2 The problems with relying on traditional usability methods for an expansion

However, the ability to design with usability in mind is no easy feat. Design practitioners often have to solve ill-structured problems with a sometimes limited set of methods, manage stakeholders, while still striving to adopt a user-centered approach (Louridas, 1999, pp. 526-528). As a result, concerns of usability might get lost in the design process as practitioners focus on the user needs that are the most explicit, which often tends to be a matter of fundamental problems to be solved and the following utility solution proposals. The designer cannot rely on the user to explicitly tell how a design can be of high usability (Nielsen, 2001).
Usability testing, i.e. the conscious and systematic effort of testing for the degree of product/service usability, circumnavigates the problem of users being unable to be explicit about their needs for usability. It tends to be resource-efficient empirical ways for identifying usability problems, but they typically come with the drawbacks of (*i)* requiring a working prototype to test, (*ii)* becoming prioritised in the overall design process, and (*iii)* requiring a certain level of practitioner knowledge (see e.g. Greenberg & Buxton, 2008). Even with the adoption of usability testing, the recognition and interpretation of the data that comes from it requires a certain level of expertise to be able to confidently act upon (Howarth, Jackson & Hartson, 2009, p. 535).

The *novice* design practitioners, i.e. new-coming or amateur designers that have no expertise or formal training in usability, have been found to be ill-equipped to identify usability problems or know what to do with usability data (Howarth, Jackson & Hartson, 2009, p. 535; Capra, 2006, 47). At the same time, novice designers are ones to gain the most from tools to help in their usability practices

(Jackson & Hartson, 2009, p. 535). Typically, design practitioners will over time gain analogical and intuitive knowledge of what characterises as good usability. Unfortunately, the process of acquiring such knowledge takes time, and expert designers might not be available to help elevate usability in everyday design processes with novice practitioners. Or, they might not be able to effectively communicate their knowledge, as Snodgrass and Coyne (2006, as cited in Greenberg & Buxton, 2008, p. 114) and Yilmaz and Seifert (2011, p. 411). Additionally, knowing when or how to include some type of usability evaluation during the span of a design process can be difficult to figure out, and the choices for when to apply evaluation may negative impact the design process, if done untimely (Greenberg & Buxton, 2008)

From this initial description of a problem space it is evident that concerns of usability are in danger of becoming down-prioritised or neglected, depending on the knowledge, resources and priorities of the given design practitioners. This holds especially true for novice designers that are either unaware, unable, or ill-equipped to undertake proactive measures for ensuring good usability.

1.1.3 The emergence of a specified problem space - Equipping novice designer with usability competencies through cognitive science

Fortunately, opportunities exist for aiding novice designers to design with usability in mind, without having to go through the strenuous process of learning through experience.
A wealth of social science and human-computer interaction research has paved the way for identifying barriers of good usability. In particular cognitive science, the vast research field of interrelating mental phenomena such as attention, memory, problem-solving and decision-making, has been a resourceful area in regards to figuring out exactly what makes a design generally easily understandable and intuitive to users (e.g. Norman 1986, 2013; Nielsen 1993; Boring, 2002; Hurtienne, 2009; Carbon, 2019). Design practitioners specialising within usability often draw upon their knowledge of cognition to help, and to some degree even anticipate, barriers for a design to be inherently usable.

Several barriers exist that makes it unlikely for novice design practitioners to readily utilise cognitive science, in an unassisted manner (Carbon, 2019, pp. 11-13; Hurtienne, 2009, p. 15). First, for those who have no prior knowledge of user cognition research, the mere acquiring of knowledge may be overwhelming. The field is wide in scope, and the sheer amount of research may hinder a new-coming designer to know what to look for (Newell & Card, 1985, p. 229; Boring, 2002, p. 1767). Subsequently, as with all research there exists a barrier in the way research

findings are communicated through domain-specific terminology. This may greatly exclude practitioners without a background in cognitive sciences in benefitting from the research (Boring, 2002, p. 1768).
Should the designer be successful in acquiring knowledge of user cognition, the next barrier exists in knowing specifically what, how and where to apply that knowledge during her various design practices. This concerns the operationalisation of knowledge. User cognition has become more than mere information-processing models, and while these more encompassing ideas better reflect findings across subfields within cognitive sciences, it also makes the operationalisation and application less clear-cut for design practitioners (Hurtienne, 2009, p. 15; Carbon, 2019, p. 11). The designer needs to be able to see a connection between her acquired knowledge and the way it may explain an aspect of the human-product interaction. Without recognising the applicational value it is quite possible that the design practitioner lacks the motivation for the initial adoption of the cognitive science, alongside the continued use of it.

Still, much of the understanding of what makes products and services comes from cognitive science. And, despite its immediate inaccessibility to novice design practitioners not previously familiar with the field there is clear potential for aiding novice designers design with usability in mind, through knowing more about fundamental user cognition.

1.1.4 Interim summary of the identified problem

For good measure, I want to sum up what the identified problem thus far. There are (*i*) a growing number of *novice* designers engaging in user-centered design (*ii*) without designing with *usability* in mind. This is problematic because it can leas to numerous design projects suffering from poor usability. As a direction for addressing this problem, one could turn to cognitive science. (*iii*) Much of the knowledge that *could* help these novice practitioners comes from cognitive science, but it is by itself inaccessible and difficult to immediately apply.
These identified barriers pose a worthwhile focus for this present thesis, which is **to develop some sort of tool to help the novice designer design with usability in mind**. As an extension to this, it is proposed that **the tool can utilise cognitive science knowledge to help understand and apply concerns of usability**. This knowledge should be applicable to the design activities the novice designer typically partakes in, and ultimately it should help in creating design concepts of higher usability.

1.2 Acquiring additional context of the problem space, part I - defining the target group

Before trying to address this identified problem space with potential solutions, I want to spend a bit more time identifying the intended target group. This is an essential part of defining the problem space, as Goldschmidt (1997) states (p. 446).

The novice designer, which for future reference in this thesis project, is a term I have chosen to use for designers with no substantial knowledge or expertise in designing with usability in mind.
Even though the majority of these novice designers are likely practising either product design, interaction design, service design, or something in the realms thereof, I have chosen *not* to exclude design practitioners outside of these subfields. The field and practice of design is, as previously stated, a vast and diverse field corresponding of many subfields. Some may define design in a traditional sense, similar to Buchanan (2001), who says: ""*Design is the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes*." (p. 9). Others may think of, and participate in, design with a wider understanding of what it entails. Mau (2007, as cited in Raahauge, 2015) stated in relation to his design symposium Massive Change: "*No longer associated simply with objects and appearances, design is increasingly understood in a much wider sense as the human capacity to plan and produce desired outcomes.*" (p. 1).

This broader definition of design can carry with it two important points. First, it is possible that new subfields of design will emerge, or that preexisting ones will have to encompass design in another way than in the traditional sense. In fact, several authors already argue in favour of this, whether it be the inclusion of the socio-technical and cultural perspectives (see Morelli, 2002), the *immaterial* side of physical products (see Folkmann, 2013), or the democratising of design altogether (see Manzini, 2009; 2015).
Second, as Nielsen (2005) previously stated there are an overwhelming number of projects that need usability expertise. While Nielsen may refer mostly to user interfaces such as websites (p. 2), it is likely that many other design projects, such as those conceived as e.g. service design projects, may *also* benefit from designing with usability in mind and being aware of general user cognition. After all, some variant of user interfaces *can* constitute parts of a design project, despite them being secondary to the primary deliverable, which could be a service or an experience (Carbon, 2019, p. 2).

For these reasons I have chosen to define my target group in terms of their lack of experience designing with usability in mind, whatever that design project may be. This is so that that the tool will be designed with a sense of generalism, in order to to be useful for the many rather than the few, which is what Nielsen (2005) advises. He states: "*How can we package usability so that it can be fruitfully applied by swarming masses of part-timers? My own answer lies in extending the work on discount usability engineering to create ultra-discounted methods.*" (p. 3).

One could conversely argue that the practising of design is very context-dependent, meaning that both the solution proposals *and* the tools and methods used in the design activities themselves have to based on the context in which the design problem is rooted (as argued in Goldschmidt, 1997, p. 454). Therefore, the creation of a tool to aid *any* novice designer with any design project may cause the tool to fall short in terms of ever being truly useful. As Woolrych, Hornbæk, Frøkjær and Cockton (2011) states: *"As with culinary dishes, HCI needs to focus more on what gets cooked, and how it gets cooked, and not just on how recipes suggest that it could be cooked."* (p. (941). This is a general sentiment that I will be continuously aware of throughout my work.
However, the intended target group for the tool *is* defined in a specific sense, in terms of them all (*a*) engaging in user-centered design processes, while (*b*) being unable to design with usability in mind. The notion that knowledge of user cognition through cognitive science could help design practitioners *across* subfields rests on the assumption that user cognition itself can be **generally** useful for heightening usability. Of course, some areas of user cognition aiding design practising inevitably depends on the context of design, being that the context can consist of specific domains of human-design interaction, or external factors influencing that given interaction. Still, the interaction with most designed products/services/artefacts depend general truths about user cognition (Carbon, 2019, p. 13). As Norman (2013) states: "Our technologies may change, but the fundamental principles of interaction are permanent." (p. 293). And, since this thesis project sets out to solve a general problem, the proposed tool must too be appropriately general for it to be applicable. This will at least be my starting assumption, when moving forward. The challenge lies in creating a tool that is both immediately understandable, applicable, enticing and empirically valid.

1.2.1 Acquiring additional context of the problem space, part II - interviewing a design and user cognition expert practitioner

Additionally to defining the intended target group for the development of tool, I also wanted to have a conversation with a design practitioner that has undergone the transition from being a designer with little or no knowledge of user cognition to

being quite well-versed in it. The intention behind finding such a profile, and not a target group-specific novice designer, has been ask about the experience and learnings acquired over time, when getting proficient with applying user cognition theory. Interviewing an expert can yield procedural knowledge, alongside reflections upon missteps done in the past and shortcomings in terms of one's knowledge disposal. Additionally, the topic of cognition can debated in itself - something that would be non-feasible asking a novice designer about.

Through mutual acquaintances, I managed to schedule an interview with Casper, a designer at the Kl. 7. behavioural design consultancy. The interview was structured loosely on common practices for expert interviews (see e.g. Bogner & Menz, 2009), but more than anything the interview was conducted at the onset of the thesis project, functioning mainly as additional inspiration, and not empirical data to directly shape the direction of the project. I took few notes during the interview in order to stay present in the conversation, and the interview was recorded for later revisiting.
In this excerpt from the interview, Casper (2020) was asked to describe how the process has been to acquire knowledge of cognitive phenomena during his beginning years as a UX designer at Kl.7. He answered:

"[It has been] Extremely hard! And I think that you really need an interest for, and general preconception of, these cognitive processes. So I definitely think that it is a general challenge as a designer to know what it is you actually have to learn and adopt. But it has gotten easier over the many years working at Kl. 7. - through all the energy I have spent putting myself into the philosophy behind it. The mindset that it really is. And then I think that you need to be able to put examples to those learnings to really absorb the knowledge." (Casper, 23:00-25:50, 2020).

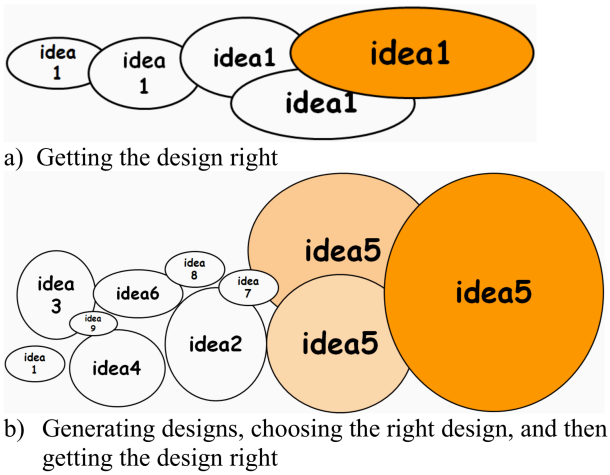
Overall, the interview left the impression that acquiring and applying knowledge of user cognition has helped his work as a design practitioner, and made him more proficient in anticipating usability problems. The usability problems are often more general than the more context-specific *'behavioural barriers'* that his consultancy is hired in to identify (Casper, 13:00-15:35). The interview reaffirms from an analogical standpoint that there indeed are fundamental principles for interaction and that these become more evident through a deeper knowledge of user cognition.

1.3. Developing cognitive science heuristics to help simplify the understanding and application of user cognition

With the initial identification leading to a problem space, there are several ways this thesis project could take from here on out. I will now discuss my approach to moving forward.

1.3.1 Amounting to a path forward - considerations of 'Getting the *right* design vs. getting the design *right*'!

As in an actual design project, once the problem has been boiled down to its core, a process begins of creating different concepts as potential solution proposals. Here, a common pitfall is to favourite one concept early on over all the other concepts very early in the process, and then spend the majority of one's time optimising that one concept. This certainly seems like a sensible approach if one were to interpret the famed Double Diamond model for the design process, from the British Design Council (2005). In the model, it seems as if all efforts are either spent in a explicitly *divergent* state, i.e. when ideating different concepts, or in a *convergent* state, i.e. the narrowing down and selection between concepts to go with. The model can in this manner be interpreted rather linearly, although it certainly is not meant that way. Buxton (2010), notably highlights this very problem by stating "*Get the right design, then get design right*." (p. 389; Greenberg & Buxton, 2008, p. 115). Essentially what is meant is that *multiple* concepts should be explored for their potential, in terms of best addressing the identified problem, before making a final choice of going with one over the others. Doing so will likely reveal which concepts may fall short if they were to be taken any further. On another note, this design quote is one of my absolute favourites.



a) Getting the design right

b) Generating designs, choosing the right design, and then getting the design right

Figure (1.1). A screenshot from Greenberg and Buxton's (2008) article, depicting the potential benefits of getting the right design before getting the design right.

Gray, Brown and Macanufo (2010) also point to this notion of exploring various concepts before choosing to go with one over the other. This is illustrated in the figure below:

My reason for showing these 'best' practices in design processes, when choosing between solution proposal is *not* to state that I myself will engage in an 'emergent' phase for this thesis. This would have consisted of fully identifying, addressing and comparing different approaches to solving the identified problem. Doing so would be a perfectly good basis for an entire thesis topic, but it would likely leave little time left to take one proposal all to the way to realisation and empirical evaluation. Rather, my reason for showing the Buxton way is instead to *declare* my intentions for moving forward from this point out. I have chosen to do somewhat the opposite of what Greenberg and Buxton (2008) prescribes, since this is a thesis project and not a design project that stakeholders have investments in. I want to fully explore, develop and test *one* potential solution for creating a tool that helps novice designers design with usability in mind, instead of spending my time comparing many. The development of this tool can of course take many possible directions throughout the thesis project but the inherent idea and theme for this thesis, which I will lay out shortly, in Section 1.4, will stay rather fixed. With thesis projects as this, there is an inherent privilege in researching for the sake of learning - as long as it fits the learning goals. And, once can do so out of intrinsic motivation.
This being said, before I go forward with my chosen solution proposal of interest I want to dedicate the following sections to exploring potential directions this identified problem *could* be addressed.

1.3.2 Addressing various proposals to aiding novice designers with usability

There are several possibilities and considerations for addressing the identified problem. Although the intended thesis focus it to 'develop some sort of tool aimed to help the novice designer design with usability in mind' there are still many ways to approach this. My presumption that utilising cognitive science as a solution may (1) only be *one* possible solution of many, and even then (2) there are still several ways to go about utilising cognitive science. This will be discussed in the sections below.

1.3.3 The different methods of usability - automatic, empirical and analytical methods

In one possible direction for the thesis project, a starting point could be to look at existing tools, methods and frameworks that have been created to make usability accessible. Here, I could opt to evaluate notable usability tools/methods by letting

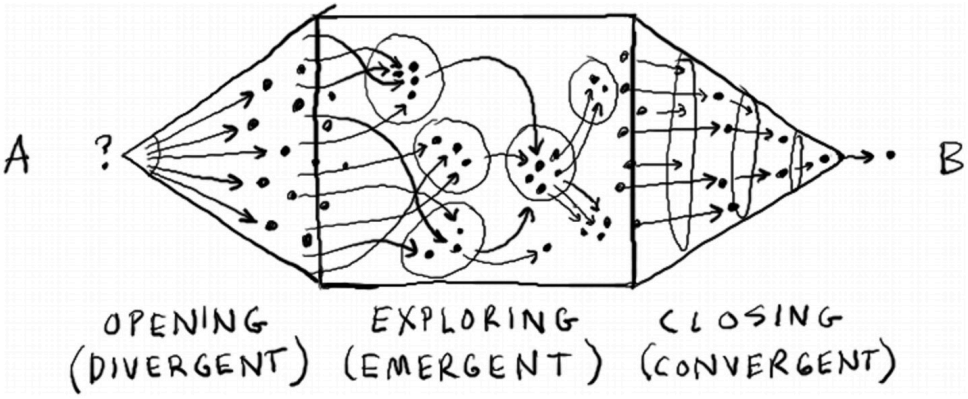


Figure (1.2). A screenshot from Gray, Brown and Macanufo (2010) on the 'emergent' phase being in-between the usual 'divergent' and 'convergent' phases of a design process.

novice designers apply them. A suitable problem statement would then be something in the lines of 'In which ways do existing usability tools and methods aid the novice designer in designing with usability in mind?'.
Here, I could take include a look at both (*i*) *empirical* methods such as various sorts of user testing (Nielsen, 1994; Capra, 2006), (*ii*) *automatic* methods such as running computer programs to identify issues (Nielsen, 1994; Ivory & Hearst, 2001), or (*iii*) *analytical* (Capra, 2006) or *inspection* (Nielsen, 1994) methods such as predicting or anticipating usability problems early on through e.g. 'heuristic evaluation' or 'cognitive walkthroughs'.

Taking the intended novice designer target group into consideration, it seems as if some methods would be of more help in terms being widely applicable in all kinds of design projects (as previously declared important), alongside fitting with the immediate understandability required for them apply the methods. For good measure, I will now go through each of the three overall categories of usability methods.

Automatic methods
For one, *automatic* methods may seem like a viable kind for novices, since it consists of 'outsourcing' the detection of usability problem to software. Howarth, Andre and Hartson (2007) found one software, DCART, that translates usability data into usability reports to be particularly useful for novice practitioners stand to benefit from. However, while I will not discard the idea that software may be able to help novice practitioners in certain evaluations scenarios, the identified problem of the

thesis projects calls for a way to help may novice practitioners across *many, diverse* design projects. Here, the designed artefact may vary. It may not be software-based interfaces, in which case automatic methods are of no use (e.g. Ivory & Hearst, 2001). However, the main problem with automatic methods could very well be that they do not make the novice designer more capable of designing with usability **in mind**, i.e. being able to include considerations of usability when undertaking user-centered design processes. This is at the heart of the thesis project.

Empirical methods

Next, there are *empirical* methods such as those found in user testing. These are the 'bread and butter', so to speak of expert usability practitioners. They involve end-users and they are often used as means for iteratively refining a product or service towards higher usability. Nielsen (2005), who had made career of out teaching and practicing empirical usability methods, stated in his Usability for the Masses paper: "*Simplified user testing has had more modest success: no matter how easy, quick, and cheap we make user testing, most companies still prefer to avoid it.*" (p. 3). And, as previously mentioned in the identification of the problem, in Section 1.1.2, novice design practitioners can besides the labour of designing and conducting user testing also have a hard time knowing how to interpret that data and make revisions (Greenberg & Buxton, 2008; Howarth, Jackson & Hartson, 2009; Capra, 2006). This makes empirical usability methods a seemingly non-viable route for empowering novice designers, at least on an immediate basis. Woolrych, Hornbæk, Frøkjær and Cockton (2011) suggest that one way could be to 'learn by doing'. This would entail to design a pedagogical and practice-led learning space for novice designers to get a feel for the various empirical methods. This would help speed up the process of gaining practical experience with usability and help create concrete learnings from it (p. 964).

However, as Woolrych et al. (2011) also points out the real-world context of project- and organisation-specific factors can all heavily influence "*configuration and combination of evaluation resources*" (p. 958). What can be deduced from an exhaustive list they provide of all these factors is that the way one can realistically expect design practitioners to utilise usability methods, here referring to those functioning as evaluation approaches specifically, is *very* context-dependent. While practice-led learning may help making usability become less abstract and more concrete, which is desirable, it may also have the potential to suffer from a lack of *transfer learning*. Here, I refer to the pitfall of assuming that novices can transfer the practical learnings they would have gotten in the learning space onto actual design projects they participate in later on (for a general review of the limitations of transfer and training-induced learning, please see Green & Bavelier, 2008).

However, there are of course usability testing methods, such as *think-aloud*, that are

of course applicable in various contexts, but Woolrych et al. (2011) still argue for a strong grasp of fundamental principles (p. 953).

Analytical, or inspection, methods

Left aside from automatic and empirical methods are *analytical* or *inspection* methods. Several traits characterise these methods. First, the can be predictive or anticipating of usability problems, meaning that they can often help improve usability to a concept before having high-fidelity prototype. They can therefore be employed earlier on in the design process, and be conducted without the recruiting of users for actual user-testing. In an overview of all analytic methods Nielsen (1992) mentions seven methods, where some are variations of one another.
The two most distinctive and important to mention are *heuristic evaluation* and *cognitive walkthrough* (p. 413).

Heuristic evaluation is the most informal of the two and it consists of design practitioners evaluating a given design concept, typically a software-based interface, using a set of 'heuristics'. Heuristics are in a design-wise context defined as …"*strategies that make use of readily accessible information to guide problem-solving.*" (Pearl, 1984, as cited in Yilmaz & Seifert, 2011, p. 385). They could also be defined as 'guidelines', or 'rules-of-thumb'.
A heuristic evaluation consists merely of thinking about, and looking at, the created concept and judging it for complying to these standards of usability (Nielsen, 1992, p. 373). In his article, Nielsen (1992) states that heuristic evaluation is intended as a "*discounted method*" (p. 373).
There have been numerous takes on creating such heuristics that enable heuristic evaluation. For example, Shneiderman (1986) provided 'Eight Golden Rules' of dialogue design, one of the earliest accounts of creating design evaluation heuristics. Tognazzini (2003), an interface designer notable for creating the first interface of Apple computers, later created a list of more general design heuristics mostly, but not exclusively, pertaining to usability. However, by far the most notable and influential set of heuristics has to be Nielsen's (1994) '10 usability heuristics'. These are the product of a factorial reduction of a long list of identified usability heuristics developed by Nielsen & Molich (1990), and they have stood the test of time as being the most commonly used heuristics. In an experiment Nielsen (1992) found that the number of usability problems found using (*i*) heuristic evaluation increase with amount of evaluators participating, and (*ii*) it increases with level of expertise the evaluators have (p. 377).

Cognitive walkthrough is a bit more formal, though not much. Here, the design practitioner(s) go through an interface trying to perform a hypothesised task, while

trying to emulate the interaction in a way that faithfully would represent the target user group. The practitioner needs either a detailed description of the interface, or possibly the paper mock-up, sketch or low-fidelity prototype of the interface (Wharton, Rieman, Lewis & Polson, 1994, p. 2). Central to conducting the walkthrough is to ask questions such as 'Will the user try to achieve the right effect?' and 'If the correct action is performed, will the user see that progress is being made toward the solution of their task?' (p. 3). As seen cognitive walkthroughs does require some from the participants as a higher level of stringency is needed to keep these things in mind, while performing the walkthrough.
In a newer comparison of heuristics evaluation and cognitive walkthroughs Khajouei, Esfahani and Jahani (2017) that the two methods do *not* differ drastically in terms of the number of usability errors being found, but cognitive walkthrough does help more in terms finding problems pertaining to the learnability of a system, while heuristic evaluation helped better finding problems that results in user dissatisfaction.

1.3.4 Reflecting on user cognition knowledge enacting as 'heuristics' for helping novice designers with usability

With the initial identification of the thesis problem I rather quickly came to the argument that utilising knowledge of user cognition will be a suitable approach to help novice designers become more capable of designing with usability in mind. And, going through the various design methods that argument remains. Hornbæk and Frøkjær (2008) argues that there are five areas that usability professionals need to understand: 'Users', 'Usability and usability evaluation methods', 'Tasks and work-domain', 'Development conditions', and 'Business goals' (p. 904). "*It should be obvious that understanding users is crucial to usability evaluation.*", they state (p. 904). And, while the authors here refer to a specification of user profiles and target demographic, I think the statement can be extended with a need for understanding 'the fundamental principles for interaction, that are permanent', as Norman (2013) puts it (p. 193). In essence, this is what design heuristics such as Nielsen's 10 (1994) Usability Heuristics provide. The heuristics, have just this past year gotten their first update with the inclusion of examples and graphics. In relation to this Nielsen (2020) states: "*While we slightly refined the language of the definitions, the 10 heuristics themselves have remained relevant and unchanged since 1994. When something has remained true for 26 years, it will likely apply to future generations of user interfaces as well.*"

It is not only the fact that heuristics about user cognition and principle of interaction, that are derived from cognitive sciences, remain relevant over time. It is

even more the fact that they hold the potential to provide some immediate help in the shape of being (*i*) easily understandable (herein the reduction of knowledge that makes a heuristic), (*ii*) widely applicable due to their general and rather context-independent nature, (*iii*) and because novice design practitioners in particular stand to get the most help from them (Reimlinger et al., 2019, p. 220).
Heuristic thinking is also core concept within psychological research, specifically judgment and decision-making. Here, heuristic thinking is defined as .."*selectively focused attention on task features that appeared relevant, introducing relevant prior knowledge in the [thought] process.*" (Evans, 1989, as cited in Evans 2008, p. 263). Here, heuristics are seen as fast-and-frugal ways of deriving an explanation to observed events, or to decide in a certain situation. There has been much debate whether heuristics are thereby beneficial for people in achieving reasonable, or even optimal, conclusions with little effort - or whether they leave the person astray with a biased decision, due to (*a*) logically relevant information being excluded or (*b*) logically irrelevant information being included by heuristic processing (Evans, 2008, p. 263). In general, heuristics can yield a favourable outcome relative to the cognitive effort being put in, given that the heuristic matches the context that it is being used to explain (Stingl & Geraldi, 2017, pp. 8-12). If not, a heuristic misuse will result in biased thinking, often going unnoticed since heuristic thinking rarely includes an evaluation of itself (REFERENCES all throughout section).

Nielsen (2005) also advises going in this direction in his paper, concerning how to expand usability beyond the usability professionals. He says: "*My own answer lies in extending the work on discount usability engineering to create* ***ultra-discounted*** *methods.*" (p. 3).

1.3.5 General arguments in opposition of utilising heuristics and user cognition

Of course there are general precautions that should be taken, when trying to support novice designers with discounted, or even 'ultra-discounted', heuristic methods that attempts to say anything about the user. With the development of any tool or method, the creator should be weary of the user misunderstanding its contents or misapplying in non-sensical contexts. In this case, designing a usability tool that gets easily misinterpreted or misapplied could lead to severe usability problems, which in the worst possible case could be a direct concern of the safety of the user (see e.g. Reason, 1995). However, when thinking of the target group, who are novice designers with *no* usability knowledge, the status quo seems equally frightening, if not more. Additionally, as Woolrych et al. (2011) argues, "*(in)correct application does not ensure (failure or) success. Although it is clear that methods can be*

incorrectly applied, this does not automatically lead to poor outcomes." (p. 942). Still, I will carry forward with a keen eye towards any potential misuse, especially if that misuse seems to be systematic.

Another aspect to be weary of will be if the heuristics ends up giving the novice design practitioners a more reductionist and flawed view of user cognition than if the designers had not adopted the heuristics. That is to say, perhaps the novice designers have a somewhat decent understanding of user, due to simply being curious about human nature. If the users then adopt a frighteningly reductionist view of users it may impair a thorough, but otherwise unstructured and non-scientifically founded, investigation of their users. As Yilmaz and Seifert (2011) discuss in their research, on how design heuristics affect creativity in novice and expert practitioners, there is a danger of design heuristics being (mis)understood as 'rules' by novices. In doing so, they would be *"a recipe that drains creativity from design."* (p. 386). While the authors refer mainly to the predominantly divergent aspect of creativity, it is possible that the concern should be extended to usability heuristics that reside en the predominantly convergent aspect of creativity.
Yet another variant of this concern would be that heuristics I propose end up distorting the novice designer's view of 'usability' as a concept. The common misconceptions of usability as a practice were outlined by Dicks (2002). However, these misconceptions revolve mostly around practitioners, who fail to employ scientific rigour in user testing. When taking into account that the intended target group are novice designers with *no* knowledge of usability, concerns of this nature are perhaps less relevant. Instead, one concern that is relevant is novices, who interpret their quick-and-dirty results from discounted methods as in indiscussable truths (pp. 29-30). As Dicks (2002) concludes: "*As long as we do this* [employ discounted methods] *without falling into the errors of claiming that we have verified usability or proven larger concepts, we will not have fallen into the trap of mis-usability."* (p. 30).
This concern of novices have found objective truth is certainly one that will be taken to heart going forward. However, with novices having perhaps no preexisting usability practices this is perhaps a lesser concern for the future than it is major concern of the present. Put differently, by helping novices do *something adequately* rather than doing *nothing perfectly* is could be seen as an improvement.

1.4 Developing heuristics with Dual Process Theory

Now, a quintessential question arises. *How should I go about utilising cognitive science in my development of the heuristics for the novice designer?*

In this section I will briefly go over the starting point for developing the heuristics by establishing a set of requirements they should fulfil. Second, I go to argue why I have chosen to utilise *Dual Process Theory* (*DPT*), a meta-theoretical framework within cognitive sciences, as the very foundation for developing these heuristics, due to perceived utility and viability of the meta-theory.

1.4.1 Establishing requirements for the heuristics

From the (*1*) identification of a problem, (*2*) acquiring additional context of the problem space, and (*3*) deciding on developing cognitive science *heuristics*, a few requirements have come to mind that the heuristics should fulfil. These are:

- The heuristics should convey **cognitive science** that is **of key relevance** for the identified target group of novice designers for better **designing with usability in mind**.
- The heuristics should be both **easily understandable** and **applicable to design tasks** that are representative of those the novice designers typically partake in.

Hopefully, from reading Section 1 up until now, these requirements seem sensical and appropriate for addressing the identified problem.
There are several different ways to go about fulfilling these requirements, and the process of doing so will not be over the course of this Section 1, but rather by working my way through the creation and empirical evaluation of the heuristics. These requirements will therefore be kept in mind for the remainder of the thesis project as guidelines for myself in my creation and evaluation efforts.
However, for the next subsections I will go into why *Dual Process Theory* has been my chosen point of departure for being able to try to fulfil these requirements going forward in the thesis.

1.4.2 Choosing Dual Process Theory as the foundation for developing the heuristics

In the writings so far a few key words have come up frequently. These are ‘novice designer’, ‘discounted methods’, ‘heuristics’ and ‘user cognition’. I mention these, because I think they provide a good basis for understanding the establish requirements, and what could be a sound approach to fulfilling those requirements.

The heuristics should be reductive guidelines providing understandable and applicable advise for the novice designer to design with usability in mind. With a premise for this project being that knowledge of user cognition, or cognitive sciences, would benefit the novice designer the question is then ‘*how* should one go about effectively communicating that knowledge?’.

Here, I see usability/design heuristics and the discounted ways the are usually being implemented as a source of inspiration for developing my proposed heuristics themselves. As previously established, in Section 1.1.3, knowledge from cognitive sciences has great potential for aiding novice designer with usability *but* the fields of research as just by themselves rather difficult to approach and immediate utilise in one's practice.

It should be note that a few notable exceptions to this immediate inaccessibility come to mind, when thinking of design-relevant cognitive research. These two theories for cognition are already being readily applied in design contexts, due to their inherent understandability and applicability. The first is *Gestalts*. Gestalt psychology concerns visual perception, and the human tendency to group visual objects in certain systematic ways. Through these perceptual tendencies, a whole sometimes becomes more than the sum of its parts (e.g. Carbon, 2019). For example, a designer can utilise the Gestalt of 'closure' to cleverly utilise negative space, since the Gestalt states that people complete shapes by filling in gaps to perceive a complete image. Gestalts have been an essential tool for designers in the field of Engineering Psychology for years (Gopher & Kimchi, 1989, p. 435).
The second is *affordances*. Affordance theory, fathered by Gibson (1966), asserts that cues can be *direct, immediate* perceptions of the environment. These cues consists of instantly detectable functions, *affording* people to interact with and make use of the surrounding environment. These affordances are created by an arrangement of substances (e.g. wood, glass, and metal) and surfaces (e.g. floors, ceilings, and walls) (Gifford, 2014, p. 30). For example, the designer can design a button to look pushable, and thereby letting the object afford the intended interaction. Affordances have since been popularised by Don Norman (2013), but there has been subsequent controversy for failing to convey the underlying dualistic human-object relationship of the theory (see Bærentsen & Trettvik, 2002, pp. 51-52).
Both of these psychological theories have managed to cement themselves into the consciousness, and into the toolbox, of the designer. This can possibly be attributed to them being immediately understandable and applicable to designers. However, they both reside within the field of perception psychology, and therefore lend themselves best to the visual, graphical, or object-shaping aspects of design. They also work as discounted design heuristics, as they provide general guidelines for how to design, in particular Gestalts. This is especially relevant for product design and interface design.

Utilising meta-theories
Going back to Section 1.2, where I defined the intended novice designer target group, I stated that these novice designers do not *necessarily* practice product design

or interaction design. Rather they could also practice service design, and other subfileds, where interfaces constitute a part of the design, but not necessarily the entire design. Therefore it is a conscious effort of mine to convey knowledge from cognitive science that is relevant for novices in understanding *general* principles of interaction, across products and services. But, then the questions arises: '*If one were to operationalise larger amounts of cognitive science in a discounted manner, how would one go about doing so?*'.
Given the established requirement for the heuristics are that they should both general *and* easily understandable and applicable to the novice designer in their practising, it hardly seems appropriate to include domain-specific research findings. Instead, I would go to argue that it should be knowledge that communicates the general findings of several areas of user cognition. It is here that *meta-theories* can prove truly useful.

In this project thesis I define *meta-theories* as 'a singular, integrative theoretical entity, which harmoniously encompasses a body related theories.' This differs slightly from some formal definitions of meta-theories, such as the APA dictionary definition, stating: "[Meta-theories are] *higher order theory about theories, allowing one to analyse, compare, and evaluate competing bodies of ideas. The concept of a meta-theory suggests that theories derive from other theories, so that there are always prior theoretical assumptions and commitments behind any theoretical formulation.*" (APA, 2021). Bates (2005) defines it this way: "*Meta-theory can be seen as the philosophy behind the theory, the fundamental set of ideas about how phenomena of interest in a particular field should be thought about and researched.*" (p. 257).
Several authors have tried to utilise meta-theories, i.e. integrative theories, to help convey the general findings from a field of science. In cognitive sciences there have been attempts, followed criticisms and counter-attempts, to summarise human cognition in a single meta-theory. Newell (1980, as cited in Teske & Pea, 1981) for example opposed the meta-theoretical nature of the 'computer' metaphor in all-encompassing information processing at the time, stating that it served as "*obstacles to correct interpretation*" (p. 127). Teske and Pea (1981) argue that these fears are not unfounded, since a reductionist approach may impair a nuanced understanding of cognition, while also hindering scientific efforts for progressing research. However, they also argue that meta-theories serve a degree of *usefulness* in conveying general knowledge in a discounted manner (p. 128), which is exactly what I need for creating my novice designer-friendly heuristics.

Some authors have of course already undergone notable efforts to establish meta-theories for human cognition. McFall (2015a) has gone through the most well-established and notable *normative* and *descriptive* accounts of cognition, which I

myself will introduce and define later on in Section 2.1.1. Thereafter, he outlined a number of meta-theories, such as *procedural rationality*, *information processing*, *reinforcement learning* and *fuzzy trace theory* of *dual process theories* (McFall, 2015b). Concluding the article, he argues that of all the meta-theories found *dual process theory* in particular helps integrate and explain key cognitive processed within learning, memory and decision-making (pp. 41-42).

I, the author, would now like to declare my motivated interest for, and belief in, utilising *Dual Process Theory* as a meta-theoretical framework for being able to help communicate general knowledge of user cognition. I will in the coming subsection define that the meta-theory is, alongside provide arguments for why I believe it is a promising way for addressing my identified problem.

A short, preliminary introduction to Dual Process Theory

Dual-Process Theory (or simply *dual process theory*), often abbreviated to *DPT,* is a meta-theoretical framework that explains various types of cognition and their relations. The main proposition of dual process theory is that all mental processes distinguished by being processes that are (*1*) unconscious, rapid, automatic, and high capacity, or (2) processes that are conscious, slow, and deliberative (Evans, 2008, p. 256). This forms an easily understandable categorisation of cognitive processes being either *fast* or *slow*, so to speak (see Kahneman, 2011). Dual process theory will be explored and defined much further in Section 2.

One of the foremost reasons for being interesting to this thesis problem is that the framework has been widely popularised outside of the fields of cognitive science, and even outside of the academic world altogether. This is likely due to the conceptual simplicity, and thereby understandability, of the framework. The two categories, *fast* and *slow*, make for a very simplistic, and in extension, compelling view of the user's mind. DPT therefore readily springs to mind, when it comes to being able to communicate cognitive science knowledge in an easy manner, appropriate for the novice designer target group.

Second, Dual-Process Theory seems to be promising in terms of simplifying cognitive phenomena that is **relevant** to user cognition, and ultimately usability itself. Because of its broad meta-theoretical type of framework, much of the primary areas of cognition emphasised in user research of the human-product interaction are also accessible through the DPT framework. Put differently, DPT seems to not only communicate general cognitive science in a straightforward manner, it also may also have the ability to communicate user cognition knowledge that is of value to the novice designers in their design practices. This includes knowledge of "higher" cognitive processes such as thinking and reasoning, memory and decision-making (Evans, 2008, 2013; Kahneman, 2011).

Arguments for utilising Dual Process Theory

There of course other models and meta-theories that could help communicate knowledge of user cognition to the novice designer. Certainly, other models have already been utilised more extensively. For example, looking within the field of human-computer interaction, much of interaction can be explained through empirical investigations of user *conceptual models* and *mental models*, as argued by Norman (2013, pp. 27-33). However, conceptual models work best as a point to be inquisitive about, when conducting research and does therefore not provide readily accessible, discounted information about the user to the novice designer. This falls well with the argument made by Carbon (2019), who advocates for an understanding of users as early as possible in the design process. He states:

> *"The reason why the claims and practical advises of so-called human-centred design approaches are still not satisfactorily followed are definitely not to be found in unclearness of writing, insufficient availability of texts or complexity or difficulty of applying these issues… …One reason for this unsatisfactory situation of persisting design problems is 'simply because [many products] have too many functions and controls' (Norman, 2013 p. 3) and so design errors take place as a matter of base probability of error. What is missing, seemingly, is the consequential application of such principles from the beginning on, not only as a side aspect or an evaluation tool. As long as we do not naturally and self-evidently take psychology as the basis and framework of design, as long as we are no 'psychologists of design', we will miss the essential points: to create products with and for humans."* (Carbon, 2019, p. 13).

Within human-computer interaction, there are of course meta-theories of cognition, such as *information processing models* (e.g. Rogers, Sharp & Preece, 2011, p. 96; McFall, 2015b, pp. 34-35), but this too suffers from the same problem of not actually providing much information for the design to actionable steps in designing with usability in mind. Additionally, classic information processing meta-theory have been criticised for failing to account for emotive and motivation-related processes, and failing to take into account the learning processes, while also not fully addressing contextual learning processes of the user (McFall, 2015b, pp. 34-35),

Then, within purely cognitive psychology research with no direct link to design there are other meta-theories aside of dual process theory that could help communicate knowledge of the user. For example, to help shed light upon cognitive load, i.e. the degree of cognitive effort required by a user in a given interaction of decision environment, much praise has been given to the *Default-Mode Network* theory, or *DMN* for short. DMN posits a default mode in the brain,

which is in a 'resting-state', when a person is not engaging in conscious, goal-directed cognition - or, if a person is engaged in a task that requires externally directed attention. When a person is *not* engaged in any goal-directed cognition the DMN is responsible for 'spontaneous cognition', including mind-wandering, states of distraction (Gronchi & Giovannelli, 2018). Ultimately, the interaction between the DMN and other areas in the brain responsible for higher-order goal-directed cognition can help explain cognitive phenomena such as fatigue, a sense of ego-depletion, and cognitive overload (Jenkins, 2019). Knowing something about how a user will get overloaded or fatigued, when interacting with a design could be of tremendous value to the novice designer. However, as Gronchi & Giovannelli (2018) themselves themselves argue, despite of being proponents for the neuro-scientific rigorousness of DMN, that dual process theory can encompass and help communicate the findings of DMN in a more approachable and communicable way.

Dual process theory, or DPT, is not entirely new. The main findings of *fast* and *slow* thinking have been attempted to be communicated to designers by Norman (2013, pp. 47-49). However, I would go to argue that DPT can be of a *higher* relevance and applicability, when not just defining the meta-theory for novice designers as Norman does, but additionally uses a simplifying framework to explain user cognition in *general*. In other words, I propose for this project thesis that dual process theory can enact as discounted method itself, for communicating aspects of user cognition that is not only understandable but also applicable for the designer, when designing with the user in mind. This is of course a premise intend to empirically investigate, and this will function as the main purpose of the thesis. With this argumentation in place, I want to proceed the thesis project by grounding my creation and empirical testing of my design heuristics around the notion of utilising DPT as means of communicating general user cognition.

From outlying the possibilities and personal motivation for using Dual Process Theory in the creation of a heuristic tool, the thesis project will take its starting point in exploring the ways in which DPT can help explain design-relevant cognitive phenomena. Later on, in Section 2 [HYPERLINK], I will go into a theoretical exploration of DPT itself, alongside the key, design-relevant cognitive processes that it can help explain. But for now, the upcoming section will take a step back and state (*i*) *what* kind of research this project thesis might be categorised as, (*ii*) the thesis Problem Statement will be revealed, and (*iii*) the thesis structure will be outlined. Lastly, I will declare the company partner, Design-People, of this thesis, and for sticking with me so far I will show you, the reader, the final developed design heuristics.

1.5 Context of the thesis

Type of research
In order to clearly establish which realm the present lies within in terms design, it useful to make a distinction between the different ways one can do research, and for what reasons. In other words, it is beneficial to look at the different types of design research.

Bærenholdt et al (in Simonsen et al, 2010) distinguishes between types of design research - research *for* design, research *into* design, and research *through* design (pp. 3-5). The present thesis lies mainly within research *for* and *into* design. Research *for* design consists of research conducted for aiding practitioners in their design processes. This can be e.g. research into the ergonomics of a product, the human-computer interaction happening during the use of an interface, or in this case research of user cognition and DPT as a meta-theory. In fact, most of design research has been research *for* design (Manzini, 2015, p. 35). The research however also consists of research *into* design, which deals more with the inquires of how practitioners go about designing. This essentially what I will go about investigating, when I later in Section 4 and Section 5 [HYPERLINK] go attempt to investigate the experience and use of my DPT-framed heuristics. Conversely, I will *not* engage in research *through* design, which deals more how knowledge is produced through the act of designing (Bærenholdt et al, in Simonsen et al, 2010, pp. 3-5).

1.5.1 Type of thesis company collaboration with Design-People
The onset of thesis began very much with the intent of doing a direct cooperation with the product design consultancy Design-People. This came from an interest in their need for agile user research methods during client projects that are often scarce in both time and resources. For this reason, and in addition that Design-People have an ongoing interest in knowledge and methods of cognitive science (Internal meeting with DesignPeople, 2020) made for a reciprocal and enticing cooperation. And while the scope of thesis has undergone quite drastic changes, primarily due to inherent limitations for physical research activities during COVID-19, Design-People have continued to be an engaged stakeholder for the duration of the thesis work.

In an introductory conversation with Stine Vilhelmsen, one of Design-People's then design researchers, she stated: "*Our clients are almost exclusively interested in getting 'Design' out of their money, meaning product development. We rarely get spare resources to do prior research, and later testing of that concept*" (Vilhelmsen, S., 2020). These frustrations seem to support the expressed interest from Design-People in the development of discounted heuristic methods. And while the project thesis will have the identified novice designer as the target group for the development of the heuristics, and not expert practitioners as found within Design-People, the heuristics may be able to provide common practitioners with additional heuristic understanding of users for especially design 'concept creation' and 'evaluation' phases, since those are primarily budgeted for by clients.
For the remainder of the thesis project DesignPeople will not have any influence of the scope and direction of the influence, since the company cooperation has since gone from being a direct collaboration to a much more passive collaboration. However, in Section 4 [HYPERLINK] they help me with feedback on my developed heuristics in a focus group. Subsequently, upon the completion and hand-in of the thesis project the company will be sent the report, as well as a custom executive summary of the project.

1.5 Problem Statement

With Section 1 coming to a close, I will now state the Problem Statement of the thesis project. The Problem Statement is a direct reflection of my path through the identification of a usability staffing problem, to the additional acquiring of context through identifying the novice designer target group, ending with the proposed DPT-framed heuristics direction for addressing the problem.

The Problem Statement is as follows:

"In which ways can Dual Process Theory operationalise as a framing heuristic for user cognition amongst novice designers, during concept creation and evaluation?

This Problem Statement will be at the heart of my subsequent efforts, and I will revisit it when needed, for ensuring a pedagogical walkthrough of the why I have undergone each efforts in the coming Sections.

1.6 Overall thesis methodology

To answer the project's Problem Statement, I have decided on an overall thesis methodology that is presented in Figure 2.3 below.

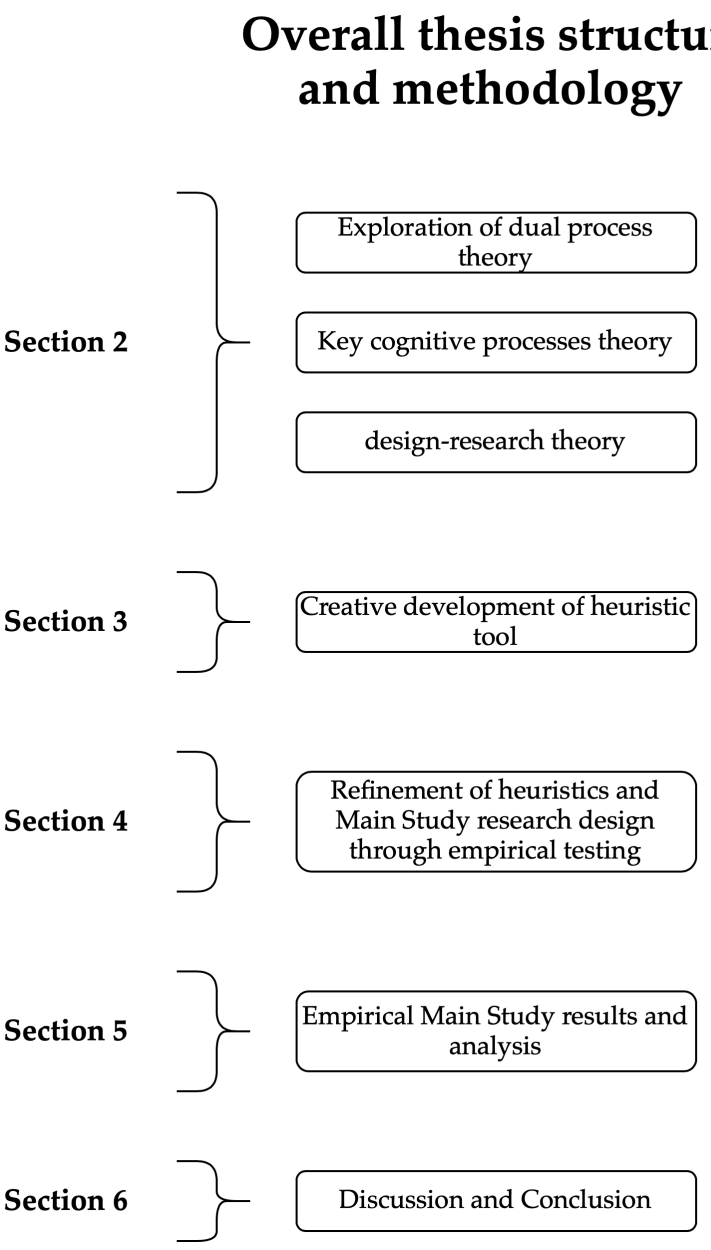


Figure 1.3. The overall thesis structure

First, (*i*) I go through a theoretical exploration of DPT and the key cognitive processes it can help communicate. I will also explore some design-theory concerning how novice designers generally utilise heuristics, as well as their needs for tools during typical concept creation and concept evaluation practices. This is Section 2.

Then, (*ii)* a set of heuristic are developed based on the previous body of theoretical work. Here, in Section 3, I undergo a creative process myself to ideate on the cognitive research, and I try to converge upon ways for effectively communicating key knowledge.

In (*iii*) Section 4 and 5 I take my proposed heuristics, the output of Section 3, and refine them through empirical testing. I then develop a research design for the Main Study, which consists of handing the final iteration of the heuristics over to some actual novice designers, who represent the intended novice designer target group. The heuristics are then tested and evaluated for their success (or lack thereof) in communicating user cognition to the novice designer participants .

And finally, (*iv*) in Section 6 I will attempt to put the output of the thesis into perspective and draw lines for possible future work.

1.7 A preview of the final usability heuristics

The entirety of the thesis a considerable mouthful. In order to be methodical I have gone through several theoretical and empirical efforts for me to approach an answer to the Problem Statement of the thesis. However, there is a defining creative and original output of this thesis, and that is the usability heuristics I have developed.
For you, the reader, to have a better understanding of what this whole project amounts to, I thought it would make an enticing introduction to present my developed heuristics, before going to the more substantially theory-heavy Section 2. The heuristics will be presented in their prototypical form in later on in Section 3, alongside being explained in detail. In Section 4 you will have the chance to see them once again in their final iteration, as I will preview them below.

Without further ado, below are the created heuristics, made with the intent of communicating user cognition knowledge to novice designers, using dual process theory.

5 GUIDELINES

for designing usable products and services, with human psychology in mind

Everyday life consist of thousands of potential decisions. To help navigate this, people generally use two types of thinking; *fast* and *slow*.

Most of what we do during our day is based on routines and habits, where we can act confidently based on our experience with something similar in the past. Not much thought is given to our decisions and actions. This is thinking 'fast'. It is efficient and our go-to way of thinking.

Sometimes, people may want to slow down and really try their best to solve an important or novel problem, using logic and being in control of thought and actions. This is thinking 'slow'. It feels hard, and our capacity to do it is very limited. All people are capable of both types of thinking. As a designer it is important to have the user benefit from both types of thinking.

These guidelines are meant to help the designer keep fast and slow user thinking in mind, when creating concepts for product designs and services. They are not meant as strict rules to follow, but rather as general sound advise. Once concepts are prototyped, it is highly beneficial to include user-testing.

1. 'MAKE THE MOST OF PEOPLES' LIMITED ATTENTION'

Be realistic about the everyday scenario(s), where your design is meant to be used. You are likely competing for limited attention with other designs and social factors. If you need users to think slow and really take in information, then take away all other information irrelevant to their current interaction.

2. 'MAKE IT POSSIBLE FOR PEOPLE TO DECIDE, BASED ON BOTH LITTLE AND LOTS OF DETAIL'

Not every decision is important to every user. Sometimes, people take the first and best thing, while not wanting to think elaborately about the consequences of that decision. Other times, they will want to go through every detail before deciding. Because some like to think slow, and others fast, designs have toaccommodate both. Show only key attributes of options, with the option to dive into detail.

3. ‘HELP USER MEMORY WITH RECOGNITION, RATHER THAN RECALLING’

> Make the current status and options visible to keep people informed of their options at any given time. The user should not have to remember, or recall, what is possible. It should be visible. This will reduce the load on memory.

4. ‘WORK WITH, NOT AGAINST, EXISTING HABITS’

> If people have a habit of interacting that does not look like what you had in mind, try to redesign your product to encompass that habit. Unless you give users a really good reason, they will think fast and do what they are used to.

5. ‘INCLUDE SURPRISING REWARDS IN YOUR DESIGN TO KEEP PEOPLE COMING BACK’

> Having people consistently engaged with your design is not always necessary, and it can be hard to build a habit that makes people automatically come back. Users will think slow about the pros and cons of interaction, unless you appeal to their fast thinking by including different rewards. Before people have made a habit of your design, they need surprise and excitement to keep coming back. Once a habit is formed, users will be less in need of rewards.

Section 2 - Theory

In this section you, the reader, will find the thesis project's theoretical body of work. The section is split into two parts, each with distinct focuses.

Part I is first (*i*) a theoretical exploration of DPT as meta-theoretical framework. Here I try to better understand DPT through its history, its current state in and outside of academia, and what it exactly can and cannot explain in terms of user cognition. I call this a 'conceptual analysis'.
Thereafter comes (*ii*) an exploration of the key cognitive phenomena that DPT can help synthesise. The exploration is really split into four parts, each depicting an overarching area within cognitive science that I deem key for being communicated to the novice designer target group. The four parts serves as the theoretical basis for Section 3, where I try to ideate and pick out a handful of useful heuristics that best portray the most relevant information from this four-part theoretical exploration. In order to not overwhelm you, the reader, in this theoretical chapter I will take *one* heuristic from my final heuristic tool, and show only the *one* part of the theoretical exploration that laid the ground for *that* heuristic. The rest of the theoretical exploration will be visible in the appendix.

Part II aims to create a theoretical foundation of design research to help understand how the heuristics should be created for novice designers to *best* be able to use them. This concerns theory from research *into* design, in particular how novice practitioners generally understand and use heuristics, alongside their respective needs for heuristic tools during *concept creation* and *concept evaluation* activities.

The theoretical work aims to provide the necessary solid knowledge foundation for me to be able to create heuristics that are both (*i*) scientifically valid (i.e. Part I) and (*ii*) formed thoughtfully with the novice designer in mind (Part II). A great deal of the efforts of this project have therefore been placed in this chapter's exploration.

2.1 Conceptual analysis of DPT as a meta-theory

You, the reader, should just have seen the heuristics, or '*5 Guidelines*' as I have called them, that I have created for this thesis project. On the face of it they might, hopefully, seem really simple. If one has a profession within design or engineering they might even seem obvious. One could then ask '*what is all this fuss getting to such simple one-liner statements?*'.
However, in order to confidently arrive to a point, where I could distill large amounts of cognitive science research into such short heuristics, where the validity of those heuristic was ensured, I had to first undergo a series of theoretical, creative and empirical efforts. In this Section, Section 2, the theoretical efforts are laid out. I will also kindly make a reminder that the theoretical (and creative and empirical) efforts have preceded the final iterations of the heuristics. As such, the Section you are about to read has been necessary for me to develop the heuristics in a rigorous manner.

Since Dual Process Theory (DPT) will serve as the foundation for creating the heuristics for the novice designers, and because it will be the defining feature that makes this thesis project distinct, I want to start the theoretical work with a conceptual analysis of the meta-theory. This is to (*i*) gain a better understanding what DPT actually is and (*ii*) what it does and does not attempt to cover in terms of cognitive phenomena. I call the theoretical exploration of this for a *conceptual analysis*, because it helps me approach an understanding of DPT as a concept. This will prove relevant when I later, in Section 2.2, attempt to highlight key, design-relevant cognitive processes that are characterised by DPT.

2.1.1 A short history on DPT, and its place in and outside of academia

The notion of some duality in general cognitive processes is neither new, nor exclusive to Dual-Process Theory. In fact, when looking at what historically precedes DPT it becomes more clear exactly what it contributes with, and to which extent its existence can help bring new value. This is why the first first part of the conceptual analysis will consist of a brief historical account.

The work historically preceding DPT
Early accounts of a dual cognition dates back to Wason and Evans (1974), who proposed one type of cognition being intuitive and subconscious, while the other being introspective and conscious.
This early conceptualisation of two types of cognition bears similarity to two distinct and opposing ideas of cognition and behaviour research, found in even

earlier work during the 1940's and early 50's. It should be noted that these conceptualisations are tied mostly to judgment and decision-making, the cognitive processes preceding behaviour concerning choices and 'do'-ing certain behaviours. This is still very much within the general realm of cognition. So, during the 40's and early 50's much of human cognition and behaviour was explained through a *normative* view, meaning that people's actions somehow must follow what is logically and rationally optimal, as pioneered by von Neumann and Morgenstein's *Expected Utility Theory* (or, *EUT*) (for an in-depth discussion of normative accounts, see e.g. Grüne-Yanoff, 2007; Beyth-Marom, Fidler, & Cumming, 2008). To put this into the context of understanding users navigating interaction with products and services, this would mean that the user always picks the optimal choice according to her preferences. Another more extreme interpretation could be that the user does not commit errors or need the possibility to undo a decision. As seen in usability research (e.g. Nielsen, 1993), this is most certainly not the case.

Then came *descriptive* accounts of cognition and behaviour, attempting to describe what people actually do, as opposed to what they should rationally do. Most notably were Herbert Simon's (1956) early accounts of *Bounded Rationality* in human problem-solving and decision-making. Simon, a central figure laying much of the groundwork for later user cognition research, advocated for people's rationality being 'bounded', or constrained by, limitations to one's cognitive capacity. As a result, the wealth of knowledge available when making a decision is often not fully utilised by a person (Simon, 1978/1992; as cited in Visser, 2006, p. 52). Instead, people's decisions and thoughts were better described through *heuristics*. Simon (1979, as cited in Grüne-Yanoff, 2007) stated that..

"*Agents use selective heuristics and means-ends analysis to explore a small number of promising alternatives. They draw heavily upon past experience to detect the important features before them, features that are associated in memory with possibly relevant actions. They depend upon aspiration-like mechanisms to terminate search when a satisfactory alternative has been found.*" (p. 550)

This way of conceptualising heuristic thinking as something that relies on (*a*) excluding most information, (*b*) drawing on past experiences, and (*c*) opting for a 'good-enough' conclusion has laid the ground for much of modern dual process theories. It also inspired research in the time between now and then, such as the Heuristic and Biases program (*HB*) (e.g. Kahneman, Slovic & Tversky, 1982) which emphasises biases, error and irrationality.

The state of DPT during recent time

Evans has since the earliest mentioning of 'dual processes' with Wason in 1974 carried on investigating characteristics, clarified definitions, accounted for variations between different dual process theories, and in general helped position DPT as a meta-theoretic framework (see Evans 2003, 2008, 2009a, 2009b, and 2019). It is however the all-encompassing prevalence of Daniel Kahneman and his work on Dual Process Theory that has popularised the framework outside of cognitive and behavioural economic research, and has even paved the way for DPT to be talked about at workplaces across industries.

In short, Daniel Kahneman has alongside his academic partner Amos Tversky conducted a series of famous experiments that show systematic deviations from economically normative, i.e. rational, behaviour. These experiments highlight not only the heuristics of intuitive and subconscious Type I processing, but additionally their experiments show that cognitive heuristics can lead to *biases*, which are systematic violation of a person's own preferences due to misadopted heuristics in certain information environments (Kahneman & Tversky, 1982). Put differently, biases are a person's continuous misuse of mental shortcuts, leading to suboptimal outcomes or outcomes that incongruent to the person's intentions.

The widespread interest in Kahneman's work, as seen in Figure 2.1, has in increased the notoriety of DPT, in particular after he first received a Nobel's prise in economics for his contribution to heuristic and bias research within economic behaviour, and second after he published a book aimed at the general public

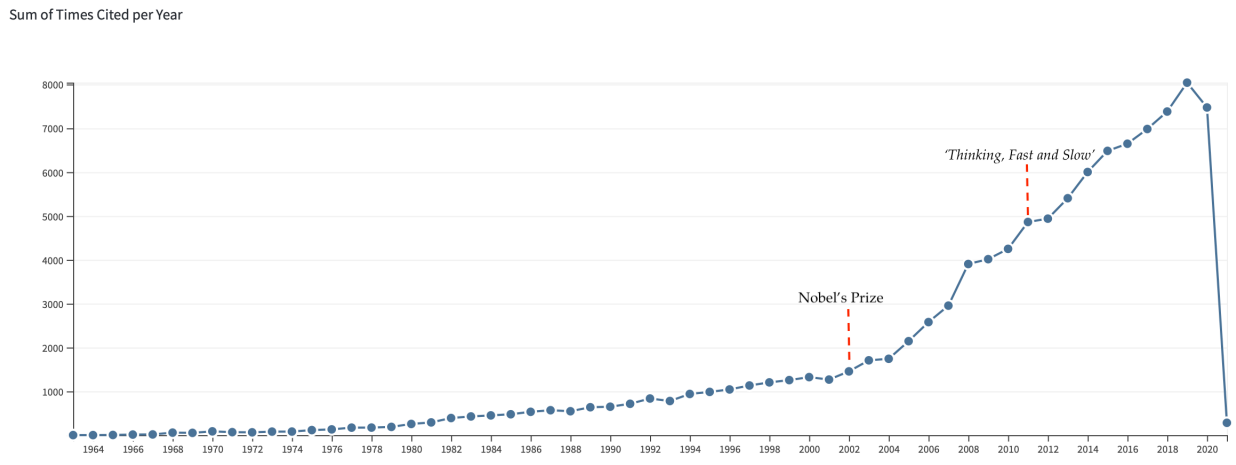


Figure 2.1. A citation report of times Daniel Kahneman has been cited per year, taken from the Web of Science database. As seen, even though his and Tversky's most seminal work were in the 70's and 80s', the popularity increased only dramatically once Kahneman received a Nobel Prise in 2002.

summarising his work legacy (Kahneman, 2013). The seminal *Thinking, Fast and Slow* paints a picture of the duality of human thought through the lens of DPT.

The popularity of Dual Process Theory is important for the positioning of this project. *Surely*, this is but one of many projects written about DPT. Though DPT retains a steady increase of research as a topic, as seen in Figure 2.2, these articles are almost exclusively within social, cognitive, neuroscience, clinical, experimental and economical psychology - *not* design, engineering psychology or Human-Computer Interaction.

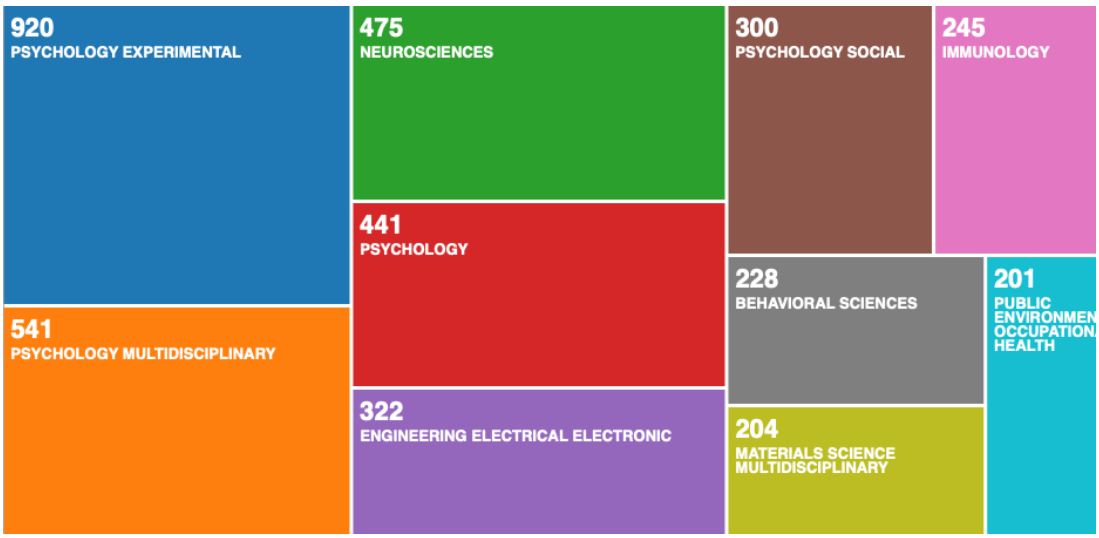


Figure 2.2 A Web of Science visualisation of which fields Dual Process Theories articles are published in. For the creation of this visualisation I used the advanced search feature and searched for: "TS="Dual Process" OR TS="Dual Process Theory" OR TS="DPT" OR TS="Dual-Process".

From Figure 2.2 it can be seen that a vast majority of articles about DPT reside within fields of psychology. It should be noted that upon inspecting the 322 articles of the 'Engineering, Electrical, Electronic' category of fields very few articles were actually DPT, but merely used the term 'dual process'. In a subsequent search using strictly 'dual process theory' as search term almost no articles showed aside within the fields of psychology.
The few articles within design and engineering that actually revolves around DPT are almost all very recent and mostly utilises DPT in research *into* design by trying to identify System 1 and 2 processes of designers themselves, when they partake in design activities (see Cash, Daalhuisen, Valgeirsdottir & Van Oorschot, 2019).
Although I will not go to an extensive search finding out *why* DPT has not manifested itself in design research, one personal guess could be that user cognition

in design typically resides within a scope on *specific* cognitive processes (relevant in specific user-product interactions) and not as much *meta-theoretical* takes on cognitive processing at large.

This trend of DPT being talked about almost exclusively within psychology makes the immediate applicational value of Dual Process Theory for novice designers perhaps seem somewhat obscure. However, the premise of this project is that DPT can enact as a simplistic way of explaining its underlying cognitive processes, the same processes that largely are subject of interest in user cognition research seen in design today. This will be done by selecting user cognition research that matches with aspects of Dual Process theories that can contributes to frame, and ultimately provide applicational and valuable knowledge through design heuristics.
But, before diving into the links between design-relevant cognitive phenomena and DPT, a scientific positioning of DPT is prioritised. Here, I will attempt to better understand differences in DPT literature of how the cognitive processes of System 1 and 2 interrelate.

2.1.2 Approaching a certain definition and scientific positioning of dual-process theories

When navigating DPT research, two general differences within the literature become clear.
First, authors vary in both their proposals for an accurate conceptualisation and terminology of the dualities of cognition. For example, authors have used 'System' (e.g. Stanovich, 1999), 'Type' (e.g. Kahneman, 2011) and 'Mode' (as discussed in Evans & Stanovich, 2013) to describe the dualities, and behind each term are different conceptualisations in terms of what entities they are. These differences will be explored further shortly.
Second, the extent to which these two families of processes are thought to interact with one another differs greatly. The relationship(s) between the two matter greatly for both understanding and applying Dual Process Theory and will also be explored further shortly.

Despite these areas of dispute there still exists a broad consensus of one family of processes being defined by quick and associative cognition and the other by slow and rule-based cognition (Kahneman & Frederick, 2002; Evans, 2008). This why it makes sense to talk about 'dual process theories' in plural, because there after all are strong unifying characteristics that make the theories somehow coherent. It is the general consensus that has drawn my initial interest towards DPT, not the opposite.

Variation in the conceptualisation and terminology of the dualities

Most crucial to understanding and defining DPT is the premise of duality. The most straightforward conceptualisation is one, where (*a*) only two single cognitive systems operate, and (*b*) these two systems are working independently in a dichotomous fashion (e.g. Stanovich, 1999). In other words, they do not 'talk' to each other, and the actions following one system of thinking will not affect or trigger the other system. Evans and Stanovich (2013) argue that DPT can sound like, and in extension be interpreted as, only two single systems, when using 'System 1' and 'System 2' as terminology, instead saying e.g. 'Systems 1' in plural (pp. 224-25). And additionally, I would go to argue that Kahneman's (2011) seminal book, and the conceptualisations made using the 'System 1' and 'System 2' terminology, paints an overall picture that appeals to a desire to dichotomise the relationship between them. Here, the two systems oppose each other in a 'night/day', or 'either/or' kind of fashion, having nothing to do with each other (as also argued by Newell, Lagnado & Shanks, 2015, pp. 215-16; Varga & Hamburger; 2014). Keren (2013) is one who advises against this desire to dichotomise, not only because it might not reflect the more nuanced dualistic relationship between the two Systems, but additionally because it can impede theoretical progress. Put bluntly, she states "*..To characterise the presumed two systems and their corresponding alleged processes strongly suggest that is has become a* [theoretical] *stone soup, where everything goes.*" (Keren, 2013, p. 257). And though it is important to state that for this thesis project the overall validity of DPT might not matter *as* much compared to working directly with the framework, rather than utilising it for its communicative value as is done here, it is still important to understand the nuances lost, and potentially even misinterpretations, that might occur when opting for a less well-reflected account of DPT in the future development of the user cognition heuristics.

By looking across influential and recent DPT literature in the hopes of understanding the most conceptually valid conceptualisations presently available, I found that the aforementioned two major types of variances, i.e. the (*1*) number of systems and (*2*) their level of interaction, can help express different conceptualisations of DPT. And ultimately, this can help discern where researchers position themselves. Below, in Figure 2.3, is a self-made coordinate system, to reflect various accounts made by researchers:

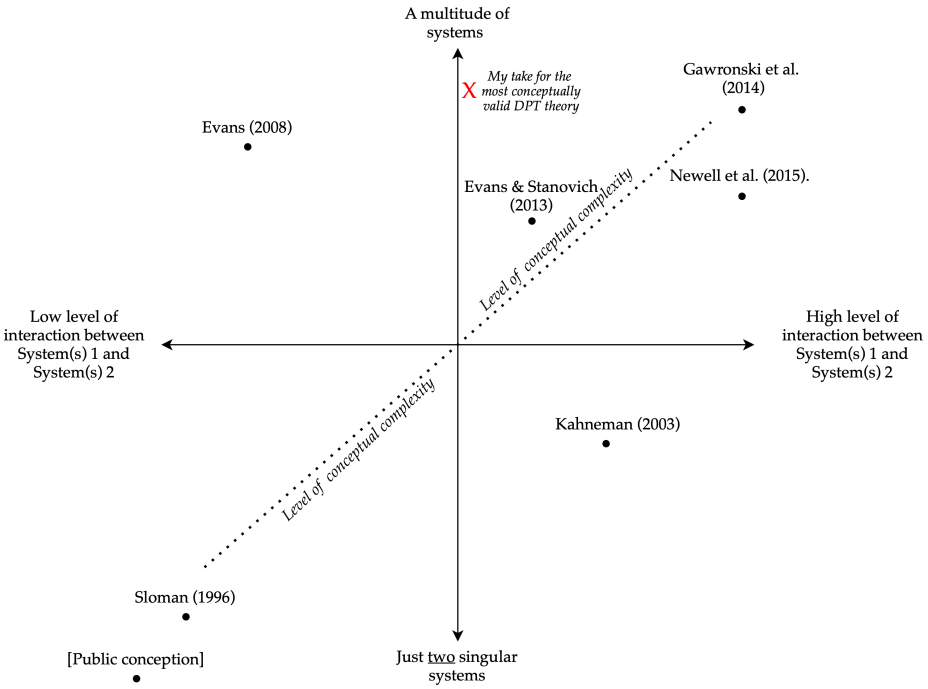


Figure 2.3. Here, a self-made hypothetical coordinate space shows different researchers ways of conceptualising DPT. On the X-axis are varying degrees of proposed interaction between Type I and II processes (from 'parallel processing' accounts on the left, to 'parallel processing' accounts on the right). On the Y-axis are varying numbers of proposed cognitive systems thought to encompass a number of distinct processes (from just two singular systems, to multiple).

On the **Y-axis** are the amount of systems conceptualised, ranging from just two singular *Systems* (as described by Sloman, 1996) to a multitude of systems that share characteristics of being either 'Type I', i.e. *intuitive* and *autonomous*, or 'Type II', i.e. *reflective*, cognitive processes (as described by Evans & Stanovich, 2013). I have placed the singular systems accounts at the bottom of the Y-axis, and the multi die of systems accounts at the top.
For both cases a taxonomy of opposite characteristics exist. The central difference is whether these characteristics are used to describe just two systems by the sum of their parts, or whether they describe several processes that can be grouped into two overarching types of processes.

An example of the implications for favouring one or the other can be found in e.g. Gawronski, Sherman and Trope (2014), in the core assumption of DPT being defined by (un-)consciousness, or automatic vs. controlled distinctions of cognition. Here, some authors argue for what is called a *disjunctive conceptualisation* of automaticity, whereby a process can be described as automatic if it is *any* of the following: (1) unconscious, (2) unintentional, (3) efficient, or (4) uncontrollable (Gawronski et al, 2014, p. 6). One cognitive process could be e.g. both intentional

and efficient, conscious and uncontrollable, or unintentional and controllable. Researchers therefore argue for a more precise use of (un-)conscious terminology as a process may be both certain aspects of automatic and controlled at the same time. This in return favours a less simplistic view of just two single, opposite systems.

The multitude of systems conceptualisation helps nuance the interplay of multiple processes. On the other hand, this increases complexity for designers to understand DPT, and acquiring a "*general* account of the workings of the human mind" (Gawronski et al, 2014, p. 7), as more simplistic, singular systems accounts would.
A simplistic, singular account would be denoted *dual process theories*, whereas the opposite would be *dual system theories*. In dual 'system' theories, a central notion is the systematic relations between multiple dualities, or the covariation of them (pp. 7-8). Evans (2008) have created an exhaustive table of these dualities, synthesising common characteristic processes of DPT literature, shown on the below page on Figure 2.4. This table gives quite a poignant view of exactly *what* characteristics of cognitive processing that DPT is able to communicate.

Table 2 Clusters of attributes associated with dual systems of thinking

System 1	System 2
Cluster 1 (Consciousness)	
Unconscious (preconscious)	Conscious
Implicit	Explicit
Automatic	Controlled
Low effort	High effort
Rapid	Slow
High capacity	Low capacity
Default process	Inhibitory
Holistic, perceptual	Analytic, reflective
Cluster 2 (Evolution)	
Evolutionarily old	Evolutionarily recent
Evolutionary rationality	Individual rationality
Shared with animals	Uniquely human
Nonverbal	Linked to language
Modular cognition	Fluid intelligence
Cluster 3 (Functional characteristics)	
Associative	Rule based
Domain specific	Domain general
Contextualized	Abstract
Pragmatic	Logical
Parallel	Sequential
Stereotypical	Egalitarian
Cluster 4 (Individual differences)	
Universal	Heritable
Independent of general intelligence	Linked to general intelligence
Independent of working memory	Limited by working memory capacity

Figure 2.4. A table of significant dual process theory attributes, expressed through their dualities alongside being covariates (made by Evans and Stanovich, 2013).

As can be seen from the table **Type I** processes, those denoted in 'System 1', are typically described as *associative* (judgements are made based on associations, often being subconscious), *automatic* (i.e. being a predisposed response to a stimuli), *slow-learning* (these automatic processes arise over a long time), *affective* (emotions and moods affect cognition and decision-making), *parallel* (multiple fast processes might go on at the same time), and *holistic* (meaning that the processes make overall judgments and understandings, but not specific ones). **Type II** processes, those denoted in 'System 2', are typically described as *non-automatic* (often being equated to 'conscious'), *deliberate* (i.e. that there is explicit, conscious intent behind them), *fast-learning* (meaning that they are quick to help bring new, disruptive information forth to consciousness), *rational* (not being affected by affects but rather by normative accounts), *sequential* (processes happen one at a time do the processing constraints), and *analytic* (meaning that individual pieces of information is discernible and able to be processed individually) (as also described in Evans 2008; Evans & Stanovich, 2013, Gawronski et al., 2014, Kahneman, 2003).

Back to the coordinate system on Figure 2.3. On the **X-axis** are the degree of interaction between the Type I and II processes, or Systems 1 and Systems 2 if you will. On the left-hand side of the coordinate system are a low level of interaction, where two systems are mostly separate (seen in e.g. Sloman, 1996). This is among DPT researchers called *Default-Interventionist* (DI) models. Here, intuitive processes (Type I) (and thus responses) are the default cognitive processing, and these are only intervened upon later by deliberate (Type II) processing if, and only if, conflict such as non-normative behaviour is detected. Thus, in DI models of the two schools of Systems, the interaction between the two Systems is only thought of as minimal and short-lived, at the point when (noticeable) conflict is detected (Newell, Lagnado and Shanks, 2015, p. 203).
On the righthand side of the X-axis are a high level of interaction, called *parallel processing* suggest that heuristic and analytic processing occur simultaneously, leading to constant and effective monitoring of conflict (p. 204). However, as Evans and Stanovich (2013) point out, the underlying assumptions of neither of these 'pure' accounts makes sense. How can conflict be detected in a DI model, when analytic processing is only engaged *when* a conflict is detected? It would need to be engaged in order to be able to detect conflict. Conversely, why would one bother with a constant slower and more capacity-intensive Type II processing, when a more 'easy' intuitive solution presents itself? The constant engagement of both does not make sense from a cognitive capacity/economic perspective, such a suggested by Simon's (1956) Bounded Rationality.
A middle ground would be a 'hybrid two-stage model', where *shallow* analytic processing is always engaged parallel to intuitive processing, in order for conflict to

be detected. Only when conflict is detected are a more encompassing analytic processing commenced (Newell, Lagnado and Shanks, 2015, p. 203). A recent study by Bago and Neys (2020) seems to empirically support this hybrid two-stage model as well, by favourably comparing its level of explainability to the more classical 'parallel processing' and 'DI' models in a series of 'base-rate neglect' problems.

A general trend in the self-proposed coordinate system in Figure 2.3 is that the level of conceptual complexity across DPT accounts, as denoted by the dotted line, increases linearly. Put differently, the DPT literature situated in the third, i.e. bottom left, quadrant is much easier to understand than DPT literature in the first, i.e. upper right, quadrant. For example, Sloman (1996) argues that there are two singular systems that oppose each other in a constant way. This is conceptually quite easy to understand. Contrary Gawronski et al. (2014) that a multitude of systems of Type I and II cognitive processes exist, with varying levels of covariation within both, and that these systems interact with each other in the less constant DI model. This is conceptually more difficult to understand. The dotted line is one that I have made myself, based on personal interpretations of these various theoretical accounts, but whether the trend is indeed e.g. linear, convex or exponential is not of much importance.
As a last effort, a mark is put on the coordinate system for the account, which from reviewing different accounts seem to be the most empirically and conceptually valid. The mark is put in-between the 1st and 2nd quadrant of the coordinate system, in that (*1*) a hybrid two-stage model of Systems best circumpasses conceptual fallacies with respect to the relationship between the two Systems, and (*2*) put further up the Y-axis due to covariation between e.g. Type I processes which are more disjunctive than all being connected and simultaneously engaged.

Going forward I will use the terms 'Systems I' and 'Systems II' as the plurality of these seem to most accurately reflect the multitude of systems within each overall types of intuitive and reflective processes respectively. When referencing a specific cognitive process belonging to Systems I and II, I will also use the terms 'Type I' and 'Type II' process, respectively..

The theoretical conceptualisation of dual process theories, and DPT as a meta-theoretical framework will be used going forward to more capably navigate in eyeing key cognitive phenomena through a DPT lens, and to help draw connections with the meta-theoretic framework that has now been explored and accounted for on its own. The upcoming section will now go into those key cognitive phenomena that DPT can help communicate.

2.2 The key cognitive processes that DPT can communicate

At the centre of this thesis project is the goal of communicating key cognitive phenomena to aid novice designers in creating usable products and services. The word 'key' implies a select number of concepts, and therefore some sort of exclusion and prioritisation. First, I want to achieve some initial sense of direction as to what types of cognitive phenomena are (*a*) useful for novice designers designing with usability in mind, and (*b*) communicable through DPT. For this, I will leverage the learnings about cognition communicable through DPT from the conceptual analysis of DPT, i.e. Section 2.1 as well as preliminary view on topics of cognition from Section 1.4.2 [HYPERLINK]. Second, I will also use my preexisting knowledge of user cognition acquired throughout past and current educations and courses. This is to make an informed decision about what kinds of cognition to focus. I am unable to focus on every relevant topic, and doing so would defeat the purpose of creating a discounted set of user cognition heuristics, being that I would likely distill knowledge from too many areas of cognition.

2.2.1 An assessment and decision of which areas of cognition to investigate

As seen in Figure 2.2, little use of DPT has been within the realm of design. This goes especially for *operationalising* DPT to communicate key areas of user cognition as I intend to. However, as stated in Section 1.4.2 [HYPERLINK], some basic mentioning of DPT, i.e. what it entails, has been done by Norman (2013). Here, he mentions that what he calls 'conscious' processing, which are Type II processes, is slow, controlled and most importantly limited in terms of resources. Going back to DPT literature, we know this to mean that Type II processes takes a large amount of effort because they involve *not* doing the automatic response, but rather one that is deliberate. It can also mean that the cognitive process is effortful because the user is trying to take all information into consideration, weigh them, and then make a calculated decision or interaction, based on all the information available. Type I processes on there other hand are fast and automatic. And, Norman (2013) states that they originate from bountiful resources. Essentially what is meant here is that Type I processes can draw on both procedural memory, experiences, habits, inherent evolutionary knowledge and more. Contrary to this, Type II processes rely on the declarative part of working memory (Oberauer, 2019, p. 48). All of this is tied together with *executive functioning*, which concerns different ways in which the user adopts control-mechanisms to modulate cognition such as working memory.

From this I deem that cognitive research of *executive functioning* and *working memory* should be included, because it seems both explainable in itself by DPT, but also because it can help explain the notion of cognitive (over)load to novice designers, by letting them know that there is this thing call working memory (WM) and it is limited in terms of capacity.

Second, Norman (2013) a lot of time talking about user's predisposed way of interacting with a product, emphasising mental models and affordances. In terms of cognition this concerns automatic processes that are often happening outside of immediate consciousness. This is very much tied to Systems I in DPT research, and the lack of *awareness* of one's cognitions. The output of these amounts to *attention* being guided by either automatic or deliberate processes. This too seems to be explainable through DPT (e.g. Evans & Stanovich, 2013, p. 228)
For this reason, I want to explore further *attention* and *awareness* in my theoretical exploration of topics of cognition.

Also related to user-object interactions that are based on mental models and affordances are the notion of habits, which too is relevant for design (Carbon, 2019, p. 5). Habits can be seen as predisposed, automatic ways of interacting in certain contexts. This is very much relevant for inquiring about *why* users sometimes will approach a design based on what they usually do, because their interactions are largely habitual, otherwise know as 'cognitive lock-in' (Murray & Häubl, 2007). Habits within user-object interaction may be better described via mental models that form *gradually* over time. Nørager (2009) argues that HCI research over the years have converge on a conclusion that designer's should try to maintain 'positional constancy', i.e. that parts of an interface stays where it usually has always been (p. 201). This could for example a shopping cart on the top-right corner of a web page. However, perhaps habit theory can enact as discounted version of mental model research, communicating simply that people are creatures of habit, and one should be aware having *good* reason to change any interactions that the users would otherwise be able to do successfully and effectively via his/her habits for interaction.
For this reason I will go investigate research of *habits* and *automatic* behaviour, and its explainability through DPT.

Lastly, a lot of interactions with a product and service can be broken down to being decisions about a certain interaction, and the preceding judgements about which decision to go with. In DPT research, Systems II are responsible for make decisions with very calculated judgments and, Systems I are responsible for decision that less calculated, less analytic and more emotional. Decision-making that is 'irrational',

i.e. not following normative accounts, has been a major part of DPT research, from especially Tversky and Kahneman (1974; 1981; 1984).
Norman (2004) has also gone to great depths trying to advocate that users interact with products based on both logic but also emotions, and that the designer can try to strategically appeal to both. With this in mind, I would like to explore cognitive research about *judgement* and *decision-making* as it seems to be both relevant for design and explainable by DPT literature.

Some of the areas of cognition that I would like to avoid including resides mainly within the perceptive part of cognition. Cognition and perception are inevitably interconnected, and perception psychology plays a large part in design. One example of this is Gestalts, as mentioned in Section 1.4.2 (Gopher & Kimchi, 1989, p. 435). And indeed, Gestalts could be communicated as *fast* percepts, i.e. Type I processes, as explored by Reyna (2012).
One could argue that the no self-respecting usability heuristics would exclude guidelines for visual aspects of design. I also do not explicitly intend to. However, taking into account that the target group consists of novice designers of various subfields, I would go to argue that by emphasising rules of perception they might favour being applied specifically for graphical interfaces, such as Nielsen's (1994) usability heuristics are meant for. Instead, the heuristics that I intend to develop should help the novice designer target group understand fundamental principle of *interaction*, where I here attempt to utilise cognition to achieve this goal. The heuristics may very well be used and applicable for specific visual design decisions. However, they will be designed not pertaining to graphics, but rather what novice designer can expect of the user in terms of cognitive capabilities.

In conclusion, I have gone around to choose to explore four overall chosen areas of cognition that seem to be the most relevant for novice designers, who interchangeably design both products and services. These are grouped as 'Executive Functioning, Working Memory and Cognitive Load', 'Attention and Awareness, 'Habits, and Automatic Behaviour', and 'Judgment and Decision-Making'.

2.2.2 On selecting Heuristic #1, '*Limited Attention*' and only one part of the four-part theoretical exploration of key cognitive phenomena

As stated in the introduction to Section 2, the four-part theoretical exploration, which will lay grounds for the *conceptually valid* development of the heuristics, is extensive is terms of length and breadth. However, it is my decision to show you, the reader, just one part of the four-part exploration. This is easy up on the length of the thesis project, but it is just as much because I evaluate the overall project

structure and methodology will stand just as clear, if not more, if I include just one of the parts in and leave the rest to the Appendix. I highly encourage you to read the subsequent three parts, since a lot of work has gone into thoroughly understanding the areas of cognition that I later creatively try to condense.

For each of the parts of the theoretical exploration I have undergone roughly the same approach. First, (*i*) I try to give a brief introduction to the given field of cognition in question. Then, (*ii*) I try to explore its relevancy for helping designers with better understanding usability. Third, (*iii*) I go to an in-depth exploration of the area of cognition to try to discern what overarching conclusions can be drawn from the body of research within the field. Lastly, (*iv*) I try to draw connections between those findings and the Dual Process Theory, to see how DPT can help communicate those findings here. Here, I try to lean on existing research showing these connections, when available, and subsequently I try to draw the connections myself in a well-argumented manner.

The one part that I have selected to show, being '**Executive Functioning, Working Memory and Cognitive Load**' is not explicitly meant to be any different from any other of the four parts of the theoretical exploration of key cognitive phenomena. They all constitute one whole, and therefore this sections might be completely representative of the rest of the work, in an 1-to-1 manner, but nevertheless I feel it conveys the general approach to exploring a given area of cognition for this section.

A sensible place one's eyes first would be with 'Executive Functioning, Working Memory and Cognitive Load'. This is because executive functioning as higher-level cognition influences and steers much of lower-level cognition. In other words, much like DPT, its influence is to be found for many aspects of user cognition and behaviour. However, as we shall see though DPT can help communicate the key findings within the areas, DPT and Executive Functioning are not necessarily synonymous.

To give an impression of what this part of the theoretical exploration has lead to in terms of later output, I want to re-show a heuristic that has been heavily founded in the work done in *this* part of the theoretical exploration, as well as the 'Attention and Awareness' part (which can be seen in the Appendix). The heuristic is Heuristic #1 of the five guidelines, which I call 'Limited Attention' for short. For good measure I will put it below:

1. 'MAKE THE MOST OF PEOPLES' LIMITED ATTENTION'

> Be realistic about the everyday scenario(s), where your design is meant to be used. You are likely competing for limited attention with other designs and social factors. If you need users to think slow and really take in information, then take away all other information irrelevant to their current interaction.

Figure 2.5. The first of the five created heuristics. It says 'Make the most of people's limited attention', and like all the heuristics, or guidelines, it consists of first the heuristic itself followed by a short explanation of why the heuristics proclaims what it does.

2.3. Executive Functioning, Working Memory & Cognitive Load

One defining aspect of what differentiates Systems I and II is the dualism of thinking intuitively versus reflectively (Newell, Lagnado & and Shanks, 2015, p. 216). Thinking reflectively is the ability to make a decision of what to focus on, meant in the broadest of terms. More specifically, that could entail actively steering one's attention towards a certain stimulus, switching between pursuits of different goals, or abstaining from temptation. It could also mean abstaining from a rushed judgment. All of these processes are comprised of general-purpose control mechanisms, called ***executive functions***, that "*modulate the operation of various cognitive subprocesses and thereby regulate the dynamics of human cognition.*" (Miyake et al., 2000, p. 50).

Early conceptions of executive functioning were unitary (see Baddeley & Hitch, 1974), meaning that a single entity was thought responsible for modulating subprocesses. Being subject to criticism for lacking specificity and enacting as a 'black box', the unitary conception has since been replaced in favour of conceptions encompassing more informative subcomponents (Packwood, Hodgetts & Tremblay, 2011, pp. 456-57). Executive functions are plural, because there are multiple control mechanisms modulating respective subprocesses. Though a debate exists over exactly how many executive functions there are (Miyake et al., 2000; Packwood, Hodgetts & Tremblay, 2011), and which hold the most relevance (Packwood et al., 2011), three seem to be emphasised consistently over others - *updating* (of working

memory representations), *inhibition* (of preponent responsens), and *switching* (between tasks or mental sets). This is so, because they appear to be relatively distinguishable and more operationally defined than higher-level executive functions like *planning* (see e.g. Miyake et al., 2000; Hofmann, Schmeichel, & Baddeley 2012).
Miyake et al. (2000) found in an extensive factional analysis, of the various cognitive tasks associated with updating, inhibition and task-switching, that the three executive functions were clearly separable but at the same time moderately correlated constructs, indicating both a unity and diversity of executive functioning - similarly concluded by Packwood et al. (2011).

2.3.1 The relevancy of executive functioning to designing

Executive functions becomes interesting in terms of designing products and services, once looking at each their modulation of subprocesses. Hofmann, Schmeichel & Baddeley (2012) draws parallels between executive functions and self-regulation, which is being defined as goal-directed behaviour, typically within a short temporal perspective (p. 174). In the realm of user interaction, self-regulation can be crucial for the completition of set tasks that are sometimes in direct competition between one another in terms of attention. Failing to act in a goal-directed manner can cause user frustration and error. Conversely, supporting self-regulation might increase the overall experience, in terms of flow, a sense of accomplishment and autonomy. For these reasons, the link between executive functioning and self-regulation will be touched upon. [SKRIV bedre argumentation].

Updating - working memory operations

The *updating* of working memory include monitoring and coding information for the relevance to the task at hand. Additionally, current items held in working memory is revisited to replace old, no longer relevant information with newer information (Miyake et al., 2000, pp. 56-57). In relation to the focused user, that means active mental representations of one's goals and the plans of interactions for attaining them. Unless these goals and their underlying execution have become fully habitualised and automatic, it is crucial to have ample working memory capacity (WMC) to allocate processing towards the updating of them (Hofmann et al., 2012, p. 175). If a product or service is placed in an environment where a lot is demanded by the user, or if the product itself has to have a lot of information, then WMC is a concept useful for novice designers being empathic towards the mental load on users.

Updating can also include a top-down control of attention away from viscerally tempting stimuli and towards goal-relevant information. With some user interfaces potentially having several tempting interactions at a given time, supporting the allocation of working memory updates towards self-concordant interactions seems crucial. In relation, *goal-shielding*, as Hoffman et al. (2012) puts it, of attention away from goal-irrelevant information makes for an active implementation-oriented mindset towards goals. When WMC is low, that goal-shielding has been found to decrease and lead to a stronger correspondence of intuitive, i.e. automatic and impulsive, processing and behaviour (p. 175). This goes for ruminative thinking as well, i.e. a dwelling on certain thoughts that the user self-identifies as being unhelpful (p. 176).

Inhibition - prepotent and 'mindless' impulses

The manifestations of inhibition in everyday life are varied. From non-urgent situations such as reaching for seconds during dinner - all the way to very urgent inhibition of impulsion from uncontrollably swerving off the road and into the woods, when suddenly seeing a deer in the headlights. Somewhere in-between those two extremes, inhibitory functions play an important part in helping the user accomplish their set goals for an interaction.

Munakata et al. (2011) distinguishes in their unified framework for inhibitory control between two types of inhibition - *active* (i.e. direct), and *passive* (i.e. indirect). Where active inhibition consists of executive information directing *when* to inhibit certain regions of processing, passive inhibition on the other hand consists of amplifying goal-directed processing through excitation of those goal-relevant regions. Put into context, a designer might help the user make inhibition of unwanted actions easier by highlighting more sound options (a case of reducing the need for active inhibition), or by giving the user reminders of their set goals (a case of aiding passive inhibition).

As with the aforementioned three main executive functions, the active and passive inhibitory systems are distinct, yet interrelated. Hoffman et al. (2012) notes that this distinction imply that both types of executive inhibition each explain their variance in people's ability to inhibit themselves from impulsive behaviour.

Switching - between tasks and mental sets

Switching one's attentional focus between different stimuli is previously described as a key feature of *updating*, and Miyake et al. (2000) seem to underline this apparent interconnectedness between the executive functions. However, where updating and inhibition seem to be essential in the support of a rigid self-regulatory goal-pursuit, switching to a greater degree supports a needed 'flexibility' in the attainments of goals. This helps to realistically encompass a certain goal in a

dynamic environment, with sometimes competing goals - or means toward the same goal. Put in laymen's terms, switching and updating might jointly be coined 'multi-tasking', since the simultaneous pursuit of two or more goals mostly consists of rapidly switching one's focus from one goal to the other very rapidly (Solovey et al, 2011; Anguera et al, 2013).
It is well-established that adaptive switching comes at a temporal cost, where the efficacy of processing takes a toll. This is especially true when that switching must be driven internally, rather than by external cues (Miyake et al., 2000, p. 55; Solovey et al, 2011). However, Hofmann et al. (2012) does point out that this switching-cost is less pronounced, when switching between different means of the same goal, when the overarching goal rather than the means is motivationally congruent.
For the novice designer, this means that it would be wise to acknowledge the limits the user's attentional focus and therefore limit goals for interacting to one at a time, and instead focus on the most salient order in which to complete steps of interaction. Otherwise, the user is at risk to repeatedly have to switch between goals, which generally leads to lower interaction accuracy, longer completion times, a higher perceived task difficulty, and increased anxiety (Solovey et al, 2011, p. 2). All of these are indicative of lower usability.

The limitations of executive functioning - cognitive load, and a step away from the marshmallow
A key characteristic of executive functioning is that its modulating capabilities have limitations. These limitations are pivotal to the general consensus within design that the interaction and use should not be 'too' demanding, by the emphasis of a 'less is more' mantra. But, although this general guideline is intuitively understood, a precursing question to a more operational set guidelines would be, '*exactly <u>how</u> are executive functioning limited?*'.

Up until recently one well liked explanation has been that people's self-control capabilities, and thereby their underlying executive functioning, become depleted through prolonged periods of continued effort. This notion of *ego depletion* was first pioneered by Baumeister (1998) and colleagues, and depletion theorists thinks of this as a physiological process. However, much research has lately disproven this notion. A large meta-analysis spanning across 83 studies on ego-depletion found that no such effect could be replicated, and that the initial positive findings were likely attributed to false positives or unreliable results (Hagger et al, 2016).
However, these results seem counterintuitive to the feeling that use of executive functioning *feels* hard.

Following theories focus on *opportunity costs* (Berkman, 2018, p. 33). Since people focus their executive functioning on one task at a time (that is, even though 'multi-tasking' appears to be happening, mostly it is just the process of rapid *switching* between attentional focuses), then other objects of interest are likely to be foregone. "*The cost of what we're giving up is reflected in the sense of effort that comes along with executive function. The feeling of depletion, therefore, reflects the tipping point when the cost of putting off alternative tasks begins to outweigh the benefit of continuing on the current course of action.*", Berkman (2018) writes (p. 33).
This seems to be in line with the more specific findings of executive functions like switching and the switching cost.

2.3.2 The associations between executive functioning and DPT

As stated at the beginning, executive functioning is a key indicator of reflective thinking, as opposed to intuitive thinking. This is because the executive functions modulate lower-level cognitive processes, and that modulation happens because a person reflectively, or actively tries to, update the information being processed, switch attentional focus, or inhibit intuitive actions (reference, plus reframe). So, executive functions are characteristic of Systems II processes, where thinking is inhibitory rather than default processes, slow rather than rapid, and high effort rather than low effort. In a literature review on dual processing, Evans and Stanovich (2013) synthesise that interpersonal differences in executive functioning and WMC are reliably predictive of performance of a wide variety of cognitive tasks and highly correlated with fluid intelligence. These dependent variables within cognitive task experiments and fluid intelligence experiments are much similar to the correlates of 'inhibitory', 'slow', and 'high effort' (pp. 235-36). The authors also highlight neuroscientific studies showing that when a conflict between 'belief' and 'logic' is detected by the brain, the anterior cingulate cortex is activated. Subsequent overriding of belief-based processing with logic-based processing is shown by activation of the right prefrontal cortex, which is known to be associated with executive control. This carries (1) first the implication that executive functioning and its control mechanisms of otherwise prepotent/automatic processes is very much tied to what is characterised as Types II processes. Second (2), it also implies that executive functioning 'overriding', once detecting belief-logic conflict, bears similarity to the Default-Interventionist account of DPT. In short, DPT and executive functions are very much related functions, and it seems promising in terms of exploring how DPT can be used to communicate the otherwise more conceptually complex aspects of executive functioning to novice designers.

This sections has through a theoretical exploration attempted to highlight key cognitive processes that are characterised by DPT, . However, as seen the modulating and higher-level processes of executive functioning seems to be best characterised by Systems II processes. These are limited, which is *why* heuristic #1 shown earlier, 'Limited Attention', prescribes to make the most of the user's limited attention, by decreasing the amount of information communicated to the user. This will decrease cognitive load. Subsequently, the novice designers are being let known that it takes effort for the user to main a focus on *their* design. This is reflection of the switching costs mentioned when using one's working memory capacity.
For an investigating the cognitive processes that correlate more with Type I processes, please have a look at the remaining three parts of the theoretical exploration in Appendix (1).

With part of Section 2 finished, I will now turn to theory within design research. Here, I try to gain an understanding of what makes heuristic guidelines useful for novice designers in particular, in order to better construct heuristics that have a higher probability of being useful, when handed over to a group of novice designers in the later empirical tests.

2.4. Design-research that promotes proper design of the heuristics

In this section I will redirect the focus onto the design practitioners. In particular I want to gain a sense of understanding of (*i*) what novice designers typically partake in, in terms of design activities. I also want to understand how (*ii*) this relates to the notion of designing with usability in mind. This is to not presume that (novice) designers automatically will benefit from usability tools at all points during a design process, and in any contexts. Third, (*iii*) I will look at *how* design heuristics might address the needs of the novice designer.

2.4.1 Typical design activities novice designers partake in

Activities partaken in when practising design generally overall similar, across different subfields and practices. This includes the structuring of the problem, generating solutions and evaluating/testing them (Goel & Pirolli, 1992). This is what Bonnardel, Wojczuk, Gilles and Mason (2018) call the *macro-process* of creative design thinking. It is true for both product design, service design, interaction design etc.
Across these overarching activities, decisions are made by the designers alternating

between engaging in *divergent* and *convergent* thinking. These overall two types of opposite thinking were originally defined by Guilford (1957). *Divergent* thinking has to do with (*a*) *fluency*, meaning a free-flowing, expressive, associate thinking and idea-generating. It also has to do with (*b*) *flexibility* to initiate, or adopt, new and unusual patterns of thought. Finally, divergent thinking has to do with (*c*) *originality*, i.e. the ability to produce truly original material (Guilford, 1957, pp. 111-117). *Convergent* thinking, on the other hand, is very much about analytically evaluating possible solutions and narrow one's decision down between a number of proposals (p. 111). Bonnardel et al. (2018) calls these *micro-processes* of creative design thinking (p. 234)

Guilford points toward *divergent* thinking receiving more praice as being a key component of creative processes, stating: "*It is in divergent thinking that we find the most obvious indications of creativity. This does not mean that convergent thinking and divergent thinking never occur together. They frequently do, in a total act of problem solving. Creative steps are necessary in solving new problems. Actually, we can hardly say there is a problem unless the situation presents the necessity for new production of some kind.*" [Guilford, 1957, p. 112].

The alternating engagement in divergent and convergent thinking is true for novice designers, as well as it is for expert designers. This means that novice practitioners also have the ability to engage in *concept creation*, i.e. a divergent generation of solutions to an identified problem, and *concept evaluation*, i.e. an evaluation of the created concepts to achieve a convergence towards a preference for one/some created concepts over others (Liu, Kao, Chakrabarti & Chen, 2016).
For future references, I would like to make use of the 'concept creation' and concept evaluation' terrminology as I find them to appropriately describe the two overarching activities of design.

However, the *way* novice designer partake in concept *creation* and *evaluation* differs significantly from expert designers. For one, novices have been found to produce *more* ideas than experts during concept creation, but also to organise them and evaluate them less effectively (Becker et al., 2018). In a study Ahmed, Wallace & Blessing (2003), comparing how novice and expert design practitioners approach design tasks, they also consistently found novice practitioners to be ineffective in particularly concept *evaluation*. Novice designers seemed to simple 'act', or 'do', instead of having explicit strategies. With the lack of knowledge of strategies at hand, the novice designers had to first implement a decision before they could evaluate it. They essentially follow a 'trial and error' pattern of not thinking ahead, but instead merely have to evaluate what has retrospectively been done. I.e. they

had no ability to evaluate concepts early in the process and therefore found it necessary to prototype and implement every possible concept (p. 6). Experienced designers differed from this by partaking in a number of strategic preliminary evaluations, before doing any actual implementation and prototyping. As a results they were found to arrive at concepts of higher quality quicker (pp. 7-8). Hu, Du, Bryan-Kinns and Guo (2019) also concluded this tendency in novice designers. They state: "*Due to a lack of convergence, novices' temporary integration of concepts is often too farfetched, rough and stiff.*" (1182).
What is even more interesting was that they found novice designers to evaluate based on different parameters than experts. Novice designers are more inclined to evaluate concepts by focusing on their own preferences, denoted as 'self-demand', and to some extent preexisting known demands, such as stakeholder requirements (pp. 1182-83). This of course goes against the explicit aims in a user-centered design approach.

The authors all advocate for equipping novice designers with external information and knowledge so that they are able to better evaluate using other concepts early on instead of using trial-and-error, and become better at evaluating based on the 'demands', or rather needs, of the user early on (Becker et al, 2018; Ahmed et al, 2003; Hu et al. 2019).

This has led to a series of authors proposing that novice designers in particular stand to benefit from design heuristics (e.g. Yilmaz & Seifer; 2011; Reimlinger, Lohmeyer, Moryson & Meboldt, 2019). Exactly how novice designers can benefit from heuristics is a topic I will go into shortly, but first I want to take a look on the former conclusion from a *usability* perspective that novices designers evaluating concepts based on needs and preferences that are not user-centered. Put differently, I want to see how the novice approach concept creation and concept evaluation corners matters of usability.

2.4.2 Novice designers and usability

The next questions concerns *how* and *when* novice designers could incorporate concerns of usability, during their typical design practices.

If following up on the previous arguments made in Section 1.1.1 and Section 1.1.2, then attempting to bring usability into the practices of novice designers via current predominant empirical methods seem futile. Even discounted user testing methods seem to be discarded as being either too labour some, foreign or unappealing (Nielsen, 2005). Looking at the Double Diamond model (British Design Council, 2005), as seen in Figure 1.2, then that would mean that the very heart of the last

convergent phase of the last diamond, the 'Deliver' phase, of building and testing prototypes would not be present. This scenario is of course problematic.
However, one could attempt to bring forth the notion of concepts being *usable* to the attention of novice designers, during the design activities they actually partake in. This could be during the concept creation and evaluation activities in the 'Develop' phase of the last diamond. As seen in the above theory, novice designers partake exactly in these activities, but they lack the knowledge and tools to do so in a strategic manner, and they do not take usability into account, when evaluating concepts.

With heuristics, such as the ones I have intended to develop, the ones you have already been shown, their discounted nature perhaps allows for designers to utilise them during their already existing concept creation and evaluation activities.

Concerns for introducing heuristic into the concept creation and concept evaluation phases

Some concerns exist, when suggesting this route. For one, heuristics that emphasises what *is* useful also, by extension, emphasised what *is not* useful. This means that heuristics that attempt to communicate what is 'good' design run the risk of critiquing novice designers' concepts at a point where critique is restrictive and counter-productive. For example, a common rule when ideating during concept creation is to "*Defer judgment*" an instead to "*Encourage wild ideas*" and "*Go for quantity*", as stated by IDEO in their seven principles for brainstorming (Hargadon, 1996). Greenberg and Buxton (2008) sheds light upon this in their article aptly called 'Usability Evaluation Considered Harmful (Some of the Time)'. Here they argue that premature usability evaluation of early design can eliminate promising ideas or the pursuit of multiple ideas (p. 112). This is essentially reflected in Buxton's (2010) famous quote, "*Get the right design, then get design right*." (p. 389; Greenberg & Buxton, 2008, p. 115), which I highlighted earlier concerning multiple concepts being explored in parallel for their potential.
However, what Greenberg and Buxton (2008) refer to is specifically usability in terms of usability evaluation to find usability problems. They argue, quite rightly, that when designers only have sketches of product concepts, then excluding certain ideas will stifle creativity and the breadth of concepts being evaluated in parallel, just because a the paper sketches representing certain ideas indicate usability problems. These usability problem might be solvable with a working prototype (pp. 114-15). Additionally they argue, that usability might be misinterpreted as *utility*, i.e. the notion of whether or not a concept is merely has the functionalities required for helping the user solve the identified problem (and not *how* it goes about best serving the user during the interaction, which is *usability*) (p. 116).

Addressing the identified concerns

I will now attempt to address these concerns. To start let me revisit the concern that usability heuristics are evaluative/judgmental and may therefore not fit into the judgment-free zone of ideation in concept creation. Reining and Briggs (2008) made a study on the so-called 'quantity-quality' relationship during concept creation. In short, most prior research on this relationship seem to support the IDEO principle for brainstorming that designers should always go for *quantity* and not care for *quality*. The underlying assumption is that 'more ideas equals a higher probability of better ideas' (Reining and Briggs 2008, pp. 405-06). However, what the authors found was that while it is true that more ideas seem to result in a select number of better, higher quality ideas, the relationship between quantity and quality is not linear. The curve flattens fairly quickly, meaning that it only takes around 30 or so ideas for it to be true that more ideas do not significantly increase the amount of 'good' ideas (p. 411).

This suggests to me that there is still potential in developing heuristics for the novice designer to be used during concept creation, without it stifling the quantity of ideas in such a way that it reduces the amount of 'good' ideas.

In addition to helping novice designers create concepts with usability in mind, the heuristics that I develop might have a positive side-effect, which is opposite to the concern of heuristics hindering the quantity of ideas (as mentioned by e.g. X). Namely, it has been found that designers often suffer *cognitive fixation* when they engage in divergent processes, such as ideation or brainstorming, during concept creation. In short, cognitive fixation means that a practitioner experiences feeling 'stuck' and unable to come up with any new ideas (e.g. Cash, Daalhuisen, Valgeirsdóttir & van Oorschot, 2019, p. 1377; Tseng, Moss, Cagan & Kotovsky, 2008, p. 217). Here, it has been found that utilising tools such as guidelines can help prevent fixation, due to designers becoming inspired by the external information present in the tools (Sopher, 2020, p. 304; Tseng et al., 2008, pp. 217-18). One could then go to think that the heuristics might actually *promote* the quantity of ideas, instead to of hindering it. This certainly seems plausible, as well-established heuristic tools, such as SCAMPER (Eberle, 1995) and TRIZ (Altshuller, 1984), have been developed specifically to be used by designers in concept creation activities

Next, in regards to Greenberg and Buxton's (2008) concerns about how usability heuristics can hinder the parallel exploration of multiple concepts, in terms of the potential. This concern rests as stated on the assumption that usability heuristics are used for usability evaluation of concepts to find usability problems. However, as Lauesen and Musgrove (2005) states, the heuristics communicating ideas of usability can just as well be used to 'guide the designer during the design process'

towards concepts that are simply thoughtfully developed from the beginning, due to general knowledge of the user and what is useful (p. 447). This is fundamentally different from using heuristics to pick out problems, as heuristics serving as guidelines may very well fit a concept *creation* activity, while heuristics serving as a means to find usability problem not.
It is my belief that usability heuristics functioning as guidelines can help novice designers with concepts fitted towards the needs of people to *begin with*, in terms of usability. This reflects back well to the prior finding by Ahmed et al. (2003) of novice designers needing knowledge and tools to get out of their ineffective trial-and-error habits of retroactively evaluating concepts for their potential, instead of proactively evaluating concepts while they are still under creation, such as expert practitioners do.

Lastly, the note from Greenberg and Buxton's (2008) on usability matters being confused with utility is indeed a matter of concern. However, with *design thinking* front and centre in the popularisation of design practices outside of educated expert practitioners, there is some reassurance that these novice designers already engage in proper problem identification and know that their created concepts should attempt to solve the identified problem. Referring back to the Double Diamond model, on Figure 1.2, I would argue that this means novice designers already engage in first diamond, meaning both the 'Discover' and 'Define' phase of identifying the problem in question.
The concern does however bring to my attention that my creation of the heuristics should be designed in such as way that they do not become misinterpreted as guidelines for finding the utility of a design but merely reflects guidelines for usability.

With these considerations of the novice designers and the introduction of usability into their preexisting practices, I will shortly explore theory that might aid me in knowing what to be aware of, when I in Section 3 attempt to create my own set of guidelines.

2.4.3 Research specific on how to create heuristics

By now it stands clear that a lot of authors argue in favour for, and call for the creation of, heuristics that help particularly novice designers design with usability in mind. However, luckily some authors have gone through the trouble of investigating *how* researchers, such as myself, can practically go about doing so. In this section I will put forward the advise, or main take-away of a few articles on this manner.

Authors Hermawati & Lawson (2016) conducted a siseable literature review, comparing 70 research articles concerning the creation and evaluation of usability heuristics. In it, they found that when researchers create heuristics, the by far most common approach is for researchers to do base their heuristic on studies of relevant literature (p. 36). A few base their creation of heuristic on a specific theory they find useful.
Essentially, I would argue that I here in Section 2 have done both, being that I have (*1*) both created a knowledge foundation for me to base my creation of my heuristics on, via the theoretical exploration of key phenomena of user cognition within various subfields of cognition. This would characterise as 'basing my heuristics on studies of relevant literature. Second, (*2*) I have also inquired in the notion of creating my heuristics over a specific theory, being Dual Process Theory. I then combine the two, by attempting to use DPT to operationalise general knowledge of cognition from my studies of cognition literature.
The literature review does unfortunately not depict exactly *how* researchers have gone around to synthesise relevant knowledge into discounted heuristics.

After that, Hermawati & Lawson (2016) investigate how the created heuristics have been evaluated. Here, the majority of researchers (34%) have did not perform any validation of their heuristics. Those who did validate their heuristics mostly opted for letting expert usability practitioners use their heuristics to see if they could identify usability issues with them. Fewer still opted for an experimental comparison between their proposed heuristics, and industry-standard heuristics such as Nielsen's (1994) 10 usability heuristics.
While I will not yet go into detail about my approach for empirically testing my created heuristics, since I have still yet to show the creation process of the heuristics in Section 3, I can say that I opt for (*1*) preliminary efforts of validation by letting usability experts try and use and critique my heuristics. Second, (*2*) I empirically test the heuristics by giving them to a handful of novice designers representative of my target group. Here, I let the novice designs use my heuristics in a set of concept creation and concept evaluation tasks, and I then interview them probing for their experience, and for the perceived value of the fast/slow terminology of DPT used throughout the heuristics. I do *not* test the heuristics experimentally for their effectiveness in helping identify usability problems.

While the literature review from Hermawati & Lawson (2016) does not give information about *how* researchers have gone around to synthesise relevant knowledge into discounted heuristics, just that they have done it, other researchers provide sound advise for doing so.

In an article aptly called 'Better discount evaluation: …', authors Somerwell and McCrickard (2005) go to show how they approach the creation the of heuristics. While the article primarily concerns domain- and context-specificity of heuristics, which is irrelevant for my creation of general heuristics to a broad and diverse group of novice designers, they go to argue that 'claims' make good starting points, when developing heuristics. Claims "*provide valuable insight into the design decisions that led to good (and possibly bad) designs*." (p. 597). For example, In Nielsen's (1994) heuristics, each heuristic is built on a 'representative opening statement', followed by several supporting and specifying high-level design issues that help a reader understand its meaning (as argued by Somerwell and McCrickard, 2005, p. 597). These jointly present what could be denoted 'claims', although some opening statements of the Nielsen heuristics are more keywords than they are calls for action, such as '#5, Error Prevention' and '#1 Visibility of system status'.
The notion of making claims and calls to action could very well be a viable way for me to go about the later formulation of my heuristics.

The synthesis of relevant information of user cognition, which essentially is the main goal of Section 3, can also take advantage not only of 'claims' and 'calls to action', it can also take advantages of *metaphors*.
In an article by Frøkjær and Hornbæk (2002) they explore how adoption of metaphors can help explain fundamental phenomena of human thinking. In the article, they base their knowledge of human thinking on the work of historic psychologist William James, and cover 5 topics, being (*i*) habit, (*ii*) stream of thought, (*iii*) awareness, (*iv*) utterances and (*v*) knowing.
*Here, I, feel compelled to make an author declaration. The article by Frøkjær and Hornbæk bears in my mind **great similarity** to the overall intention of this present thesis project. In a similar way, I *too* try to synthesise fundamental user cognition via the metaphor of thinking *fast* and *slow*. Beyond that, like the authors I also try to account for (*a*) the importance of designers knowing these fundamentals of user cognition, and I (*b*) try to account for its relevancy in designing. Even my chosen topics of cognition to explore and synthesise, see Section 2.2.1, bears great resemblance to the topics of cognition conveyed by the authors. The resemblance is in certain instances uncanny. Some underlying methodological differences differences do of course exist. For example, while I use the fast/slow metaphor from dual process theory to help communicate knowledge of cognition, I also utilise DPT as the meta-theoretical framework that it is for cognition, in order to provide a theoretically coherent account of the different areas of cognition.
I feel a sense of great appreciation for having found this article, but also a certain degree of frustration having only just found a few weeks prior to the completion of the project, as it could have been a source of inspiration throughout.

But I digress. The article by Frøkjær and Hornbæk (2002) does show that metaphors can enact as powerful tools of communication. I find this especially relevant in terms of conveying knowledge of user cognition, which as previously stated is otherwise dominated by inaccessibility due to domain-specific terminology. As such, it could very well prove useful to create the heuristics with metaphors using the *fast* and *slow* reductionist terminology, as popularised by Kahneman (2011).

With the body of theoretical coming coming to a close, I now turn towards the process of developing a set of heuristics, based on the theoretical exploration.

Section 3 - Design/development of heuristic tool

In this section you, the reader, will be taken through the creative process that I have undergone in order to develop a prototype of my usability heuristics. I call it a 'prototype' because I intend to iterative and refine the content and format of it through initial testing and validation in Section 4.

The creative process will consist of two overall activities. First, I (*1*) set up an *ideation workshop* in order to (*i*) engage in a divergent brainstorming process, trying to come up with different ideas for heuristics, or pieces of heuristics. The ideas for heuristics were created with the intention of validly conveying the knowledge of cognitive science explored and accounted for in Section 2. Then, I (*ii*) engage in a convergent selection process, where I try to take the ideas that seem to reflect the most useful cognitive knowledge, in terms of conveying information that is both generally useful and have the potential to be readily applicable for novice designers.

Second, I (*2*) try to decide on the format for communicating these heuristics, based on the design-research covered earlier in Section 2.4.3. The output will be a prototype of a set of heuristics that I can test in Section 4.

3.1 Activity 1 - Ideation 'workshop'

The creative procedure for creating the set of heuristics is going to be split into three phases. This is with inspiration from the conceptualisation of Gray, Brown and Macanufo (2010), shown earlier in Figure 1.2 [HYPERLINK]. First, (*i*) a *divergent* phase was initiated, where ideation of heuristics, or parts of heuristics, or even starting points for heuristics, took place. The outcome here was to produce a multitude of ideas for heuristics communicating cognitive science knowledge. Second, (*ii*) an *emergent* exploration phase sought to look at the produced ideas, to better understand whether single ideas might be entail several interpretations, and whether there is interconnectivity between the ideas. Third, (*iii*) a *convergent* phase consisted of selecting a subset of conceptually distinctive, whole ideas that seems to hold up against a set of constructed criteria for ideas being applicable and understandable.

3.1.1 Phase I: Ideating concepts - the *divergent* phase

Where divergent phases typically benefit from interpersonal idea generation, carrying through the process as a sole participant is certainly possible as well. In fact, though the benefits of group ideation are lost, such as being able to build upon others' ideas as well as having more minds help increase the quantity of ideas, some drawbacks are avoided as well, such as power differences between participants obstructing a productive and free flow of ideas (Hanington & Martin, 2012; Amabile, 2016).

Phase I is designed in such a way to support ideation, while ideating on my own. Here, the very foundation for ideating will be based on the seven principles for ideation by IDEO. These are instrumental to achieving and maintaining divergent thinking, as originally characterised by Guilford (1957), and can be repurposed as an inner dialogue for when ideating alone (Hargadon, 1996).

The seven principles are (*1*) 'defer judgment', (*2*) 'build on the ideas of others', (*3*) 'one conversation at a time', (*4*) 'stay focused on the topic', (*5*) 'be visual', (*6*) 'wild ideas should be encouraged', and (*7*) 'go for quantity' (Hargadon, 1996, p. 694).

For the context designing a set of heuristics, rather than some service or piece of industrial design, the principle of 'being visual' will be taken lightly due to the primarily written nature of design heuristics.
The principles which have an interpersonal connotation, such as 'defer judgment' are those especially suitable for repurposing as inner dialogue. As an example,

deferring judgment can in a solo session mean that one must try to keep an open mind, i.e. restrain oneself from engaging in early convergent thinking.
One notable distinction between the facilitation of this ideation phase contra the facilitation of brainstorming activities typical for the design of a given product or service is that the set of heuristics are really *several topics* being ideated on at once. For a typical brainstorming activity, a single problem is being stripped down to its bare essential to focus a large quantity of ideas on that select topic (Hargadon, 1996). For the set of heuristics the overall ideation phase really consists of ideation from the multitude of theoretical topics explored in Section 2.2 (including those store in the Appendix X.X). One way to describe this would be several brainstorm activities being undertaken, possibly concurrently. The one unifying factor however is the distillation of cognitive knowledge into design heuristics.

In order to avoid potential chaos of ideating on multiple heuristics from *multiple* theoretical topics, Phase I will in addition to initial classic brainstorming procedures adopt an ideation tool called the *Scope Wheel* framework, developed by insight consultancy Bespoke (Dyrman et al. 2018). The Scope Wheel is developed to direct diverse brainstorming activities on several topics, one at a time (p. 60).

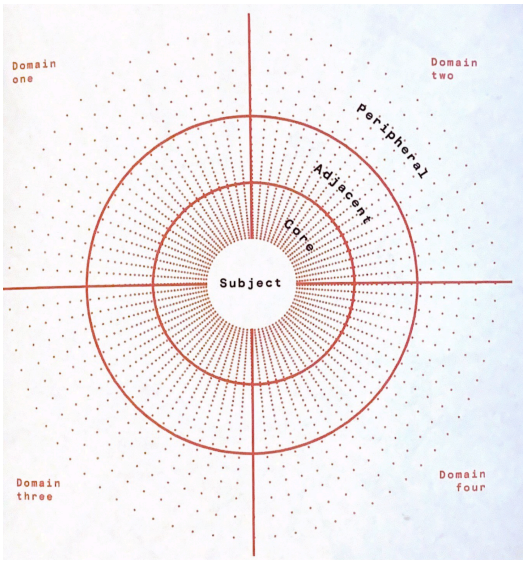


Figure 3.1. A screenshot of the Bespoke's 'Scope Wheel' framework, which helps designers ideate on multiple topics sequentially. Additionally, it can help with the exploration phase of ideas, by arranging them into the 'core', 'adjacent' and 'peripheral' categories, each depicting varying levels of conceptual similarity to the subject being ideated on.

Procedure
The ideation of concepts started with drawing a simplified version of the Scope Wheel on a large sheet of paper. This essentially meant just drawing a large circle and dividing it into six slices, or 'domains' as Bespoke calls them (Dyrman et al. 2018). It should be noted that the reason for dividing it into specifically *six* slices was that at the time of the ideation process I worked with a then understanding of six areas of cognitive science that I theoretically investigated. These were later merged in various ways into the four categories that are mentioned in Section 2.2. The Scope Wheel traditionally contains additional information of so-called 'hierarchical levels', but these were excluded for now in the divergent Phase I ideation.

Then, I wrote the names of each of the six topics of cognition being worked with at the time. These did not attempt to correspond one-to-one to each of the parts of the theoretical exploration, but rather aimed to portray the clearly distinguishable theoretical themes, when looking back at Section 2.2 in retrospect.

The ideation process the began by (*i*) repeatedly setting a timer to one minute, six times in a row, for ideating first things that come to mind relating to the theoretical topic in question. I used the same yellow-colour post-it note for each of the ideation rounds. This was to quickly get already-formed ideas or thoughts down that I may have subconsciously thought of before commencing the Activity.

Then, after a short break, I began (*ii*) setting the timer repeatedly to two minutes to as before go through a round of ideating upon each of the six areas of theory.
As a final effort, I once again set the timer, this time to five minutes per area. This would give me hopefully an adequate starting point for quantity of ideas to then later explore.

Results
The result of Phase I was a total of *72 ideas* for heuristics based on the cognitive science exploration The amount of ideas was somewhat equally distributed across the six slices, or domains, of topics ($\mu = 10{,}28$, $SD = 1.75$).

The ideas did at a glance seem to have different levels of specificity. This was explored in the coming Phase II, in the *exploration*.

3.1.2 Phase II: Exploring concepts - the *emergent* phase
After ideating, the process was slowed down to take a good look at the post-its created. This is was named the *emergent exploration* phase. Here, the goal is to

understand what each written note is referring to in terms of cognitive phenomena, making sure no note is written without an identifiable meaning in mind. Some of the post-it notes contain merely a single key word. This of course can lend itself to a decreased outward transparency of the creative process, in terms of depicting exactly what is meant with each of the 72 ideas. However, these key word notes were deemed apparent to me, and seeing as I ideated alone, I found it sufficient to not (yet) formulate ideas for anyone but me to inherently understand.

Procedure

When exploring, all notes were deemed to have adequate meaning, albeit several may have indirect meanings. What is meant here is that some refer to real-world examples of the given cognitive science topic at hand. In other words, some were created out of *analogical similarity*, which is defined as information about other design projects, or design methods, that the design practitioner can become inspired from Tseng et al. (2008). Since all notes were equally understandable both during and after the time of writing, no notes were rewritten.

Next, I began a process of implementing the 'hierarchical levels' that are originally included in the Bespoke Scope Wheel. This means drawing two new smaller circles within the perimeter of the large drawn circle, effectively creating three levels within each of the domains of cognitive science.
This was done to explore the conceptual relation of the ideas on each post-it relative to the given topic of cognition having been ideated on. In the so-called 'core' level, I simply put a large purple post-it with the name of the topic of cognition at hand. There were one purple post-it for each of the six domains.

Then, I began the process of categorising each of the 72 post-its into either the 'adjacent' or the 'peripheral' level. The difference between the two levels was made clear from, besides being apparent from in which inner or outer circle the ideas were put, using a specific colour of post-it notes for each of the levels. I opted keep the yellow colour post-it notes for the 'peripheral' level, and orange post-it notes for the 'adjacent' level. This decision was based on fact that I could save my time manually rewriting the content of *every* post-it onto a differently coloured post-it, and instead only have to rewrite for *one* level, that being the 'hierarchical' level.
Of course, this comes with the implicit bias of lazily categorising fewer post-its as hierarchical seeing as those would need be rewritten, whereas those categorised as adjacent would not have to be rewritten. This is well-described by the *status quo* bias, originally by Samuelson & Seckhauser (1988).
For this reason, I tried to be aware of the bias, while engaging in the categorisation.

Results

The resulting output of the exploration can be seen in the below in Figure 3.2 [HYPERLINK], in the now filled-out Scope Wheel:

Figure 3.2. A picture of the created Scope Wheel. Here, all the ideas from Phase I are evaluated for their meaning, and categorised into either the 'adjacent' and the 'peripheral' levels of the wheel.

As can be seen a majority of ideas were categorised as 'peripheral'. Of course, this could be influenced by the status quo bias as mentioned, but it could also be influenced by the simple fact that there was more space in the peripheral circle, seeing as it was the outermost level. Therefore, it may have 'afforded' being filled up with more notes than the smaller adjacent level has. Still, it was my experience that the Scope Wheel helped organise the post-its in a manner similar to tree-like flowcharts, where categories turn into subcategories and sub-subcategories. Here the amount of concepts typically also increases the further down you go of the branches.

I will now include some examples of the different levels of conceptual similarity of the ideas, i.e. which ideas were put in which level. For example, in the core topic of

'Executive Functioning' I then ideated 'WMC', i.e. Working Memory Capacity, and found it here to be 'adjacent' to executive functioning. This was because I recalled from my theoretical exploration, seen in Section 2.3, that working memory as key component of understanding the central executive, and that the concept of working memory was highly relevant cognitive science knowledge to communicate to novice designers, being that it could possibly have them become more understanding and empathetic towards the limited capacity that people have in terms of WMC. Subsequently, I put the post-it saying 'Cost-benefit of *switching* = Ego[-depletion]' into the peripheral level. This is because the concept of users being unable to constantly switch their attention and processing between different tasks is a topic less conceptually close to executive functioning, but still relevant. And, in this example it is also a post-it note with a more refined statement, meaning that instead of being merely a vague starting point for a heuristic, it could actually serve as part of a finished heuristic.
Another example is found in the core topic of 'Judgements & Decision-Making'. Here, I put the post-it saying 'J[udgements] = Combine, Weigh'. This refers the important step in a judgment process, where users have to take the informational cues that they acquired through *discovering*, *acquiring* and *ordering* that information and the have to combine the cues and weigh them in terms of probability and affect (See Appendix X.X). This is particularly interesting for designers, when they have to design services, where a lot of options are available and the user then can run the risk of having to combine and weigh many, many informational cues, making it cognitively effortful and possibly even overwhelming. Then, I put post-its saying 'compensatory' and 'non-compensatory' in the periphery because these are two predominant approaches that users have for engaging in this 'combine and weigh'-ing of information. Yet again, the ideas put in the peripheral level are less conceptually close to the core topic, but no less relevant for my understanding of what cognitive science information to base my creation of heuristic upon.

After this emergent exploration phase, where ideas where (*i*) investigated for the clarity of meaning and (*ii*) explored for their conceptual proximity to the overarching topics of cognition being ideated from, I then went on Phase III. Here I attempted make a selection of the ideas that seem to hold the most value being further investigated for their potential to create understandable and applicable heuristics.

3.1.3 Phase III: Selecting concepts - the *convergent* phase

From here, the last phase is to undergo systematic converging. The post-its are evaluated in terms of their potential to make a foundation for, or merely to inspire, cognitive heuristics that are both understandable and have general applicable value

for designers. Here, post-its are not depreciated because they for example only contain if a single cue word, so long as that ties to a topic with possible potential.

For the act of converging *Dot-voting* was used. Unlike its regular purpose, where dot-voting can help a group create agreement on how to converge by going for the most voted, i.e. popular, topic(s) (Gray, Brown & Macanufo, 2010, pp. 63-64), dot-voting is here used to help articulate otherwise unspoken preferences when working solo.

Procedure
With all post-its still fresh in mind from the exploration phase earlier that day, 20 dots were cast onto the post-its, with a self-imposed time limit of ten minutes. During the span of these five minutes, votes were initially all put down to then subsequently be rearranged as to best reflect personal preferences for those portraying the most potential. One dot was never used, as the time limit was reached, and there seemed no need to enforce exactly 20 votes, as the number was chosen arbitrarily.

The dot-voting procedure happened on a basis of favouring certain post-its more than others in terms of the *potential* for being able to communicate both understandable and applicable heuristics of user cognition. Because of the fact I would allow myself the possibility later on to go back and revisit the library of the ideated post-its, I did engage in the voting process based on a set of strict criteria. Rather, the voting was based on educated guesses, stemming from my time theoretically exploring the various topics of cognition, their relation to matters of usability, and their degree of explainability via DPT, as seen in Section 2.2 and Section 2.3 and Appendix (1).

Results
The resulting cast of votes is seen below, Figure 3.3:

Figure 3.3. A picture of the Dot-voting outcome, where 19 dots where placed on the seemingly most promising ideas for creating understandable and usable heuristics.

From it a list of 19 post-it notes where it derived. However, contrary to regular dot-voting practices this process was *not* with intention of limiting myself exclusive to the 19 fragments for concepts in the post-its. It is not in this moment at the process, where I make a hard decision of *what* the heuristics should be. Rather, it served as guiding hand for me gain some sort of direction for knowing where to direct my creative efforts later on, in Activity 2. For the reasons just stated, I will not present a long list of the 19 post-it notes with subsequent descriptions of the thoughts behind them. Instead I will place my efforts into the description of how I went about formulating heuristics from this *overall* 'Ideation workshop', being Activity 1.

3.2 Activity 2 - Heuristics development

With the completion of the ideation workshop of Activity 1 I then sought to commence a process of going from a selection of promising ideas, with the subsequent library of other less seemingly promising ideas, onto the creation of concrete heuristics.

3.2.1 My approach towards the development

Documenting the process of the heuristics development proved no easy feat. As Guilford (1957) mentioned previously would state, the act of divergent and convergent thinking can often occur in unison in the act of creative problem solving. This is perhaps why, in the literature review of 70 studies focusing around developing usability heuristics, authors Hermawati & Lawson (2016) could *not* find information into general approaches for the very development of heuristics - only the research that precedes making them, and the subsequent testing of them once created.

However, with pointers from the prior theoretical work in Section 2 I tried to make a list of the few features that I knew I wanted to explore and likely use during the act of developing the heuristics. The list is outlined below:

- *Include fast/slow from DPT*.
  - The very premise of this project is to explore the ability of DPT as a framing heuristic for operationalising knowledge of user cognition. Therefore, I want to opt for using the obviously approachable discounted, or reductionist, view of DPT popularised by Kahneman (2011); that user thinking can be explained through the notion of thinking either *fast* or *slow*.

- *Use 'claims' and calls-to-action.*
  - In order to increase the likelihood of making the heuristics applicable I want to use communicative tools of *claims* and *calls-to-action*. As stated by Somerwell and McCrickard (2005)

As exemplified in the Frøkjær and Hornbæk (2002) article metaphors hold strong communicative value, when trying to give forth information of otherwise rather complex knowledge of cognitive science. For this reason I will make good use of the most popular and simplistic metaphor stemming from Dual Process Theory; thinking *fast* and *slow*. Although the metaphor is more direct, and to a degree less visual, than the metaphors outlined by Frøkjær and Hornbæk, it is indeed still a metaphor. Different from a *simile*, i.e. a comparison between two things to create new meaning, a metaphor is figure of speech that uses one thing to mean another. Saying e.g. 'The habitual behaviour is *like* thinking fast' does not carry with it the same direct and visual painting forth to the receivers mind as saying 'The habitual behaviour *is* thinking fast'. Judging by the popularity and likability of Kahneman's (2011) metaphor I will not attempt to make up a more useful metaphor for Type I and II processes than this one that already exists, in and outside of academia.

Second, following the advise by Somerwell and McCrickard (2005) I will attempt to make use of *claims* and *call-to-actions*, when formulating the heuristics. As such, I will try to formulate my heuristics in such as way they become more 'action-oriented' and in extension more applicable than merely stating a fact about user cognition.

It should also be noted that I during the development of the heuristics tried to keep in mind the requirements I have previously set for myself for the heuristics to fulfil. These are in Section 1.4.1, but for good measure I will restate them below:

- The heuristics should convey **cognitive science** that is **of key relevance** for the identified target group of novice designers for better **designing with usability in mind**.
- The heuristics should be both **easily understandable** and **applicable to design tasks** that are representative of those the novice designers typically partake in.

The requirements give a good understanding of how the developed prototype of the set of heuristics should viewed.

3.2.2 A presentation of the developed prototype of the heuristics

Now, I will present the developed heuristics, and afterwards explain some of the early iterations they went through. Five heuristics were created. The developed heuristics for this creative process that is Section 3 are shown below:

The reader with a good recollection might notice that this prototype of the set of heuristics is largely similar to the final iteration previewed in back in Section 1.7. The process of how I went from this prototype of the heuristics into a very similar final iteration Will be explained in the upcoming Section 4.

3.2.3 The reasoning behind the created heuristics

Now, I want to briefly describe the different formatting variants that I went through in the development of this, and the go through the reasoning behind the (*i*) introductory piece of text, and (*ii*) each of the five heuristics.

Formating variants

The heuristics were chosen to be very text-driven. This bears great similarity to the most notable existing usability heuristics being widely used have been exclusively text-based, such as Nielsen's (1994) 10 Usability Heuristics (see also Shneiderman 1986; Tognazzini, 2003). While I do not prescribe to an idea that heuristics *should* be text-based, or even *partly* text-based, I seemed both a promising and resource-efficient way to develop my first prototype. Additionally, I lessens the probability of me inadequately conveying cognitive science in **valid** way, given that illustrations and symbols may have higher degree of variance in the ways they become interpreted by the receiver, i.e. the novice designer, than concretely written text does.

The most prominent area of going back and forth between different variants of the heuristic formats pertained the *order* of the claim and the call-to-action. I tried both variants, meaning that I first had a one-liner claim about how users think, i.e. the claim,, according to a given principle of cognition, and then a more encompassing body of text beneath that explains what the designers should do, i.e. the call-to-action.

From trying to apply these differing variants of the heuristics myself I found that the combination of (*1*) first putting the call-to-action and then (2) the claim worked the best. This is because of two reasons. First (*i*) having the call-to-action as a short, headline makes the heuristics more action-oriented. By just looking at the heuristic designers are told a **guideline** for how to design with usability in mind, rather reading a seemingly inapplicable fact about cognition. Then, after reading the call-to-action the novice designer is likely to be engaged with the given heuristic and may therefore be curious enough to go ahead and read to below claim, which is made sure to formulate as an explanation as to *why* they should act on the above call-to-action. This hopefully makes the heuristic both immediately engaging and

5 rule-of-thumbs, for designing with human psychology in mind.

People generally use two types of thinking; fast and slow. Most of what we do during our day is based on routines and habits, where we can confidently act based on our experience with something similar. Not much thought is given to our decisions and actions. This is thinking 'fast'. It is efficient and our go-to way of thinking.

Sometimes, people may want to slow down and really try our best to solve an important or novel problem, using logic and being in control of thought and actions. This is thinking 'slow'. It feels hard, and our capacity to do it is very limited.

All people are capable of both types of thinking. As a designer it is important to have the user benefit from both types of thinking.

———————

These rule-of-thumbs are meant to help keep the user in mind, when creating concepts for product designs and services. They are not specific guidelines as designs vary. Once concepts are prototyped, it is highly beneficial to include user-testing.

(1)
'Make the most of peoples' limited attention'
Be realistic about the everyday scenario(s), where your design is meant to be used. You are likely competing for limited attention with other designs and social factors. If you need users to think slow and really take in information, then take away all other information irrelevant to their current interaction.

(2)
'Make it possible to decide, based on both little and lots of detail'
Not every decision is important to every user. Sometimes, people take the first and best thing, while not wanting to think elaborately about the consequences of that decision. Other times, they will want to go through every detail before deciding. Because some like to think slow, and others fast, designs have to accommodate both. Show only key attributes of options, with the option to dive into detail.

(3)
'Help user memory by recognise, rather than recall'
Use visibility to help users keep informed of their options at any given time. The user should not have to remember what is possible, it should be visible. This will reduce the load on memory.

(4)
'Work with, not against, existing habits'
If people have a habit of interacting that does not look like what you had in mind, try to redesign your product to encompass that habit. Unless you give users a really good reason, they will think fast and do what they are used to.

(5)
'Include surprising rewards in your design to keep users come back'
Having people consistently engaged with your design is not always necessary, and it can be hard to build a habit that makes people automatically come back. Users will think slow about the pros and cons of interaction, unless you appeal to their fast thinking by including different rewards. Before people have made a habit of your design, they need surprise and excitement to keep coming back. Once a habit is formed, users will be less in need of rewards.

Figure 3.4. The developed prototype of the heuristics. It consists of 5 heuristics that each start with a 'call-to-action' headlines, and then a 'claim' about how user cognition functions, relevant to the respective headline. The call-to-action and the claim together forms a 'heuristic', which there are five of.

credible, by arguing for the proposed guideline. Second, I found that in the variant where I put the call-to-action beneath the claim, the call-to-action too became a body of text stating more precisely different aspects of the *what* the designer should do. This made the heuristics **less general**, and in extension possibly more context-specific, which is opposite to my intent developing the guidelines for the diverse ***novice*** designer group (as also argued by Daalhuisen, 2014, pp. 28-30).

Reasoning behind the introductory text of the heuristics

For the creation of the heuristics, I opted to include both the heuristics, which can be seen as guidelines or rules-of-thumb, and also a piece of introductory text. In it try to keep the requirements of Section 1.4.1. mind, as previously stated.

The introduction consists of two parts. First, I have attempted to distill the overall message of Dual Process Theory into an easily digestible description of 'fast' and 'slow' thinking. In it, I tried to be reductionist and pedagogical in my way of writing. In order to not distill a *distorted* reductionist view of human cognition I start with the words: "*People generally use two types of thinking; fast and slow.*" I saw it necessary to not make the impression that *everything* in terms of user cognition could be explained best through 'fast' and 'slow' thinking, but rather that they were general characteristics of cognition.
Second, towards the end I write the following: "*All people are capable of both types of thinking. As a designer it is important to have the user benefit from both types of thinking.*" With this sentence I try to make it clear that 'fast' and 'slow' are not personality types. I would be a direct misinterpretation if novice designers started seeing their users as *strictly* 'fast' or 'slow' thinking individuals, irregardless of the context or information environment in which the are. Also, I think it provides a nice transition to the heuristics themselves, where the designers are concretely advised to design in such a way that promotes, or nurtures, users's possibility to engage successfully in either 'fast' or 'slow' thinking.

Towards the end of the introduction I also included an **instruction** to help the novice designers know how to use this heuristic tool. Here, I write: "*These rule-of-thumbs are meant to help keep the user in mind, when creating concepts for product designs and services. They are not specific guidelines as designs vary. Once concepts are prototyped, it is highly beneficial to include user-testing.*" The intention with this instruction is for designers to feel free about their choice to use, or not use, the heuristics as they see fit. In addition advise to not let the heuristics replace other genuine efforts for understanding the user and designing with usability in mind. As such, I encourage the novice designers to also include user-testing

Reasoning behind the heuristics themselves

For the heuristics themselves have two overall goals in mind, originating from the self-proposed requirements. First, they should convey knowledge of user cognition that is **valid**. In other words, the information that is communicated should accurately reflect the theoretical findings that I have based them on from the theoretical exploration. To help achieve this I have opted to go back and forth between my theoretical exploration of the key cognitive processes that DPT can communicate, in Section 2.2 and Section 2.3 and Appendix (1). This ensured that I did not rely on a vague recollection of the theoretical findings, but rather had them in front of me, when trying to distill their essence in the heuristics.

Second, I wanted to heuristics to all be relevant and **distinctive**, meaning that no two heuristics could say the same thing. This desire led to the creation of five heuristics, as I found those to be just the right amount to say enough without repeating myself, while taking into account not to overload the novice designer. This is not to say the the heuristics cannot be related, or that some did not come from the same area of cognitive science research. In fact, some did with Heuristic #4 and #5 both originating from habit research. The reason for these two to be separate is that I found two important and distinctive conclusions that I wanted to convey in each their own heuristics, respectively. It is true for every heuristics that I tried reduce the point to a **singular** call-to-action. Similarly, although less obvious, Heuristics #1 and #3 both partially origination from research on memory. The reason why it is less obvious is because Heuristic #1 states 'Make the most of people's limited attention', and #3 states 'Help user memory by recognise, rather than recall'. Both os these are partly founded upon theory of memory, the former being WMC and the latter being episodic memory.

I will now briefly attempt to convey the cognitive science knowledge that I have attempted to convey in the heuristics. The full scope of the theoretical exploration preceding these heuristics is best understood by looking at in Section 2.2 and Section 2.3 and Appendix (1). As such, I will not try to dive too much in the theory here, and I will not include references to a significant degree:

1. '***Make the most of peoples' limited attention***'
   - With the first heuristic I try to express a very basic and very general point from user cognition research. It is in fact so basic that I suspect many intermediate practitioners to merely glance past it. However, since this heuristic tool is meant for the *novice* designer with no knowledge of usability and human thinking, I found it appropriate to start with.

- The heuristic is founded on theory of WMC, in particular how (*i*) the top-down *updating* of one's attentional direction, (*ii*) that internally driven adaptive switching comes at a temporal cost, where the efficacy of processing takes a toll (e.g. Miyak et al., 2000), and lastly the (*iii*) fact that users also feel a sense of 'depletion' coming the temporal cost of adaptive switching, where the efficacy of processing takes a toll. The temporal cost is due to users continuously weighing the costs and benefits of staying attentive towards one thing (Berkman, 2018). All this amounts to the solid, well-known general guideline that attention is limited, that designers should expect too much of their users attention-wise, and that to aid designers one can remove unnecessary items of information.
- I equate the conscious top-down steering of attention with 'slow' thinking and states that the capacity to do so is limited.

2. '***Make it possible to decide, based on both little and lots of detail***'
   - The second heuristic is derived on what I would argue to be a very underused area of cognition research for usability and HCI; that area is 'judgment and decision-making'. The heuristic applies for every design concept, especially within types of service design, where the has to make a decision between multiple alternatives.
   - Here, judgement theory, as described in Appendix (1) is valuable for understanding that once users have acquired information about their possible alternatives, two predominant ways of deciding between them can be utilised. First, the user can adopt a *non-compensatory* strategy, which entails the user (*i*) disregarding much of the informational cues of each possible alternative and (*ii*) makes as discounted *satisfactory* decision, i.e. decision strategy that saves energy while providing a 'good-enough' outcome. This is commonly know as 'satisficing'. Alternatively, the user can adopt a *compensatory* strategy, which entails the user looking a probabilities for each possible outcome of going with one alternative over the other, and subsequently assigning weights to those probabilities based on preferences and affect. Users have been found excellent to discover informational cues but poor at assigning weights to them (Newel et al., 2015). Still, this strategy mostly outperforms compensatory strategies, but it more costly in terms of cognitive effort. This is commonly known as 'maximising'.
   - Rather than biases and other popular theories, of all the judgment and decision-making theory I found this to be the most design-relevant. The designer can accommodate both decision-strategies by showing only key attributes of options, with the option to dive into detail.
   - I equate non-compensatory decision-making with thinking 'fast' and compensatory decision-making with thinking 'slow'. I also state to some

people in certain situation like to engage in one over the other, and that designers should accommodate both.

3. '***Help user memory by recognise, rather than recall***'
   - The attentive reader might instantly 'recognise' that this heuristic is merely a rewriting of Nielsen's (1994) 'Recognition vs. Recall' heuristics. I made the decision to include in my set of heuristics because (*a*) out of all 10 of Nielsen's heuristics I find this one to be the least context-dependent in terms of applying specifically to a subset of graphical user user interfaces. Second, I find (*b*) it to be relevant in terms of promoting the visibility of information and interaction possibilities for the user.
   - In short, the heuristic is based on the general notion that *recognition*, i.e. the act of visually identifying something based on past memory, is less memory-intensive than *recall*, i.e. the free retrieval of episodic memory (e.g. Aggleton & Brown, 2006).
   - I chose to slightly rewrite the heuristic to emphasise readability and for pedagogical purposes. This something Nielsen (2020) himself has since done, in particular with this specific heuristic, indicating that important it may be hard to understand in its original form.
   - For this particular heuristic I did not attempt to explain it further through 'fast' and 'slow' thinking.
4. '***Work with, not against, existing habits***'
   - The fourth heuristic is derived on research of habits, and implicitly also research of mental models. Here, I try to convey the general notion that users are 'creatures of habit' so to speak, and that they are largely predispositioned to interact in ways they are used to with similar products.
   - This builds on theory of habits being very strong predictors of user interaction in a given specific context (Bruijn, Gardner, van Osch & Sniehotta, 2014).
   - Meanwhile, habits are cognitively very resource-efficient, being profoundly automatic.
   - I therefore advocate designers to design *for* habits, instead of *against* habits as they are both efficient ways of interacting (in terms of being resource-effective, but *not* in terms of receiving and adapting to feedback (Jager, 2003), and because it is dangerous to assume that users can readily change their habitual responses.
   - I equate habitual thinking with 'fast' thinking.
5. '***Include surprising rewards in your design to keep users come back***'
   - The final heuristic is considered the most eccentric, so to speak. It is also derived on habit research, but contrary to the other four heuristics that reflect very classic guidelines within usability, this last refers more to newer user psychology research of *behavioural design*.

- I Included this because it seem novice designers are very much operating with fields of 'innovation' and entrepreneurship. Here, emphasis has been put on building habit-forming products and services (e.g. Eyal, 2014).
- Here, I wanted to make useful guideline by largely stating that attempting to build build habit-forming designs is *not* always necessary and most certainly easy, since habit formation is longitudinal an unlikely (Wickens et al., 2007).
- *However*, if the designer deems it appropriate the most resounding conclusion for doing so is to make use of (*i*) rewards that are (*ii*) timely varied (Wickens et al., 2007)
- I equate habit formation with users thinking 'slow', unless the introduction of surprising rewards appeal to their 'fast' thinking.

With this presentation of the developed heuristics, and the reasoning behind them it is now time to move forward to the empirically derived refinement of the heuristics, alongside the building toward a research design for testing them with novice designers.

3.3 Conclusion to section 3

In Section 3 I went through the creative, but also intellectual, process that has taken place to arrive to a proposal for a set of heuristics. I went through the Ideation 'workshop', where I created an agenda for myself to undergo ideation, exploration and selection of ideas for the creation of the heuristics. I then tried to account for the process of developing the heuristics, based on the work from the workshop. Finally I tried to explain my rationale for (*1*) the format of the heuristics ad well as (*2*) the intent with each of the heuristics, alongside the cognitive science that they aim to communicate. I also show how I make use of the 'fast'/'slow' metaphor throughout the heuristics.

With Section 3 coming to an end it is not time to go ahead an empirically refine the heuristics, test them for their conceptual validity, and approach a research design for studying the use and experience of novice designers utilising the heuristics.

Section 4 - Research Design

In this Section I will go to outline the overall research design and methodological considerations for evaluating the proposed design heuristics. This includes an outlining of **three** concrete research activities, where learnings from each activity will help inform subsequent efforts. In this chapter the results of the two first research activities will also be presented and discussed, since these studies are meant to be the learning grounds for setting up the third and final research activity, which is thought of as the main study.

Lastly, validity considerations will be discussed. This includes a general account of how validity is conceived and accounted for in this project.

4.1 Establishing overall desired learning outcomes for research activities

Revisiting the problem statement, seen in Section 1.3, the central focus of the thesis is to investigate *in which ways Dual Process Theory can operationalise as a heuristic for user cognition amongst novice designers, during concept creation and evaluation*.

There are several research activities, which would promote a encompassing investigation of such problem statement. The process of research to be conducted is best conceived as two parts.
Part one, denoted ***Initial inquiries*** for future reference, consists of **two** research activities. These seek out to optimise the heuristics, alongside optimising the ways of investigating the experience and value of using them. This is crucial to maximise learnings, when being able conduct research with representative novice designers.
Part two, denoted *Main study* for future reference, consists of **one** research activity. Here, conducting the planned research activity with representative novice designers will be done, based on the learnings from two research activities comprising the Initial inquiries.

Below are three respective focuses that will be put during the Initial inquiries research activities:

1. Preliminary assessment of the validity of the proposed heuristics
2. Possible adjustment of heuristics, in terms of content and presentation
3. Pilot testing and refining the procedure for testing the use of the heuristics

4.2 Conceptualising validity for the Initial Inquiry - a general account

For different research realms exist different ways of conceptualising 'validity', alongside best practices for reducing the likelihood of an invalid interpretation of data.
For this project, aiming to create heuristics that synthesise cognitive science knowledge in a valid way, validity is perhaps not as easily addressed as with for example experimental research, or even qualitative interview research. Looking at quantitative experimental research, validity is broken down into different key types, such as *content*, *construct*, *internal*, *external*, and *criterion-related* validity, all

being specific and operational inquiries of concern for research (REFERENCE). Conceptualising validity for the process of constructing heuristics leans much more toward accounting for validity as it is done in qualitative research. Here, concerns are most often specific to the research method in question, such as interviews (see Brinkmann & Kvale, 2015) or case studies (see Flyvbjerg, 2006). However, on a general level, validity in qualitative research is about continuously verifying the correctness and strength of a statements. In a seminal article Morse et al (2002) goes to argue that validity generally can be ensured by a continuous verification of one's efforts. Several *verification strategies* are mentioned. The authors have later refined their take on these verification strategies, stating that they "*are inherently built into research processes and are ultimately pragmatic—not a matter of meeting a standard in some type of checklist but a process of continually verifying and adjusting to ensure issues are identified and corrected as the research develops and the theory evolves.*" (Spiers et al, 2018, p. 1).

Relevant for ensuring validity of the heuristics themselves are for one the strategies of 'sampling adequacy' (Morse et al, 2002, p. 18). Here, finding the participants who best represent, or have knowledge of, the research topic is essential. Second, the authors argue that rather than reaching *saturation*, i.e. a continuous reoccurrence of the same findings, by asking a participant several times it would be wise to bring in new participants (p. 20). Second, 'collecting and analysing data concurrently' ensures a mutual interaction between what is known and what one needs to know (p. 18). I interpret this as the general sense of iterating based on early research findings, which also seems to be the main argument of continuous verification. This is why I will go to inform a prospective research activity by the research preceding it. Second, I aim to have sampling adequacy in mind when the validity of the heuristics, by recruiting participants relevant that differ in their knowledge of user cognition, and the synthesising of that into design heuristics.

4.2.1 Preliminary assessments of the validity of the proposed heuristics

At the present moment, the proposed heuristics are constructed based on a singularly acquired understanding of cognitive science and DPT. Only one set of 5 heuristics have been chosen to be tested, due to their face validity for being sound, accurate, and general pieces of cognitive science knowledge. In addition, they are deemed too compliment each other, in terms being conceptually connected without overlapping in a senseless way.

However, this is of course not a given, as work carried out by only one individual often lacks the refinement and accurate judgments possible by interpersonal discussions (see e.g. Gigone & Hastie, 1997).

Therefore some sort of assessment from other practitioners of cognitive science would help reassure that the heuristics indeed convey valid pieces of information. Therefore a preliminary focus will be to establish one such assessment of the content of the heuristics.

More elaborately, the elements of the preliminary assessment includes:
- Academic characterisations of the cognitive science in each heuristic.
- First impressions of the set of heuristics as a whole.
- Perceived use
- Perceived value
- Identified pro's and con's of the given heuristics in their current form

4.2.2 Method
To facilitate a discussion, and herein to get multiple perspectives on the validity of the heuristics, a focus group interview has been chosen. A focus group has the benefit of bringing forth different, sometimes conflicting, opinions on a topic (Brinkmann & Kvale, 2015, pp. 173-74; Dawson, Manderson & Tallo, 1993, pp. 3-4). Here the statements of one participant can spark the reflection of another. Furthermore, contrary to individual user testing of a product or concept that is very in-depth, focus groups can be resource-efficient ways of getting a diverse set of opinions at once. This requires of course that the researcher, or moderator, creates a welcoming space for all opinions, even those opinions are objections to questions and assumptions made by the researcher (Brinkmann & Kvale, 2015, p, 280).

Due to this activity being the first of the Initial Inquiries, less effort was placed on conducting an exhaustive focus group. The motivation for doing so was to get the majority of knowledge able to be extracted with the prospective participants, but not necessarily all knowledge.

4.2.3 Participants
Whereas recruiting fellow students sometimes means a lack of participants representative of a desired target group, for the purpose of testing the synthesising of cognitive knowledge fellow students of Engineering Psychology are actually quite fitting. This is due to the unique and distinct focus on cognitive science and its ability to inform usability efforts of the education.

Three participants were recruited to the focus group, all women aged 24 to 26. All participation happened without monetary compensation.

4.2.4 Procdure

The focus group was conducted virtually using Zoom, due to then COVID-19 restrictions. 45 minutes had been set aside to conduct the activity. At the beginning, participants were asked verbally for consenting to having the conversation recorded.
The participants were familiar with the overall purpose of the focus group prior to their participation.

The research activity started with a verbal introduction of the intended use case of the heuristics. Then, the participants were given five minutes to individually read through the heuristics, followed up by the opportunity to ask for any clarifications.

Then, being the main focus of the research activity, the participants were asked to individually, and without conversing with each other, to **characterise** each heuristics in terms of what underlying cognitive phenomena the given participant thought the heuristics aims to synthesise. They were asked to write their characterisations down. Subsequently, the participants were asked to read their thoughts aloud with the option to elaborate verbally.

Next, the focus group discussion began with participants discussing their experience of the heuristics. Specifically, the discussion was moderated with the leading questions of (1) general impression, (2) Perceived value, (3) intended use case, (4) length/amount of heuristics, (5) cognitive knowledge that was found not included, (6) con's, and (7) pro's of the heuristics.

At the end, the participants were asked if they anything to add, or any questions to me or one another. And they were thanked for their participation A full focus group guide can be seen in appendix (2).

Note-taking procedure

As a means of achieving less time spent later on retrieving participants' inputs and comments, I chose to actively take notes during the focus group. Only few times did I ask for the conversation to be put on hold, while I noted down the last phrases spoken out. Otherwise, it was possible to let the conversation flow freely, while noting each point down.

4.2.5 Results

After the activity, the audio recording of the focus group was played back in full, while adding to the document of notes what may have been missed during the mid conversation note-taking. The raw document of notes taken can be seen in

Appendix (3). To provide an overview of the results, two tables are created. Table 4.1 shows which cognitive phenomena the participants thought the heuristics each tried to synthesise, respectively. Table 4.2 shows the opinions voiced on perceived use, value, pro's, con's, and other comments on the heuristics.

Heuristics	**#1 'Limited Attention'**	**#2 'Maximise/ satisfise'**	**#3 'Recognition over recall'**	**#4 'Work with habits'**	**#5 'Include rewards'**
Characterisations made					
Tilde (T)	'Distracted attention'	'Maximise vs. satisfise'	'Recognition / schema'	*Use seen-before solutions	'Motivation'
Christina (C)	'Limited attention'	*Design for use case	'Recognition over recall'	*Build on known gestures	[N/A]
Rebecca (R)	'Distracted attention/ overload'	'Choice overload'	'Recognition over recall (Nielsen)'	'Negative transfer'	*Gamification

Table 4.1 An overview of the characterisations of perceived cognitive phenomena underlying each heuristics, stated by the three participants. The characterisations in apostrophes ('') are referencing cognitive phenomena, while those with in an asterisk (*) reference non-psychological but design-relevant phenomena.

TOPICS	**Results** (T)	(C)	(R)
First impression	#5 was the only difficult	Heu's seem obvious	Might need concrete tips for application
Use	[N/A]	Heu's can be used to assure quality in the eyes of clients	It's an evidence that you haven't just made stuff up
Value	Great if you want to save resources, when not using user testing. And ideal, combined with user testing.	A shortcut for using less energy.	**Acts as a time-saver, and wouldn't overpower with background knowledge - a 'hack'!**

TOPICS	Results (T)	(C)	(R)
Length/amount of topics	[N/A]	Manageable. Perhaps heu's #1 and #3 could be merged.	**Not at all overwhelming, compared to Nielsen's 10 heu's, which are difficult to remember.** Have thought of including Gestalts?
Pro's	[*Mentions again the ability to enact as a usability shortcut*]	[*Mentions again the ability to enact as a usability shortcut*]	People have heard about Kahneman beforehand, so I think a lot would find this intuitive.
Con's	The 'slow' part of fast and slow is not immediately understandable. **Perhaps an intro to fast/slow would be useful?**	**Currently, they comprise on aesthetics, which reduces readability - perhaps include a separating box or two.**	#1 is inconcrete (when is 'much' too much) - the '7 +/- rule be easier'
Other comments	[N/A]	[N/A]	People often don't read advice, so be realistic. Most things are on the internet, so include hyperlink. Remember to make clear the heuristics aren't 'law', but merely guiding.

*Table 4.2. An overview of the most clear statements made by participants in the focus group discussion. The statements are divided into the moderated topics constituting the focus group. Statements written in **bold** indicate points where the majority of participants agreed.*

Conclusions to feedback

The first and foremost evaluation to the focus group is to look at Table X.X for consistencies between participants in their characterisations of a given heuristic.

Validity check

Here, all five heuristics seem to be characterised either fully or partly in line with the preconceived notion of what area of cognitive science I have aimed to synthesise.

More specifically, three heuristics (#1 'limited attention', #2 'maximise/satisfise', and #3 'recognition overrecall') are characterised perfectly by all participants. These

showed an immediate recognition and understanding of the cognitive phenomena being synthesised.
The remaining two heuristics (#4 'Work with habits', #5 'Include rewards') were partially characterised correctly. This that interconnected, or adjacent, pieces of cognitive phenomena was expressed trying to characterise these heuristics. For heuristic #4, 'work with habits', this meant participant Rebecca explaining habits/mental models and their role in product interaction through *negative transfer*, which is the process of previous learnings interfering with, or obstructs, with present learning (see e.g. Fiske & Dyer, 1985). This phenomenon relates well to the obstruction habits can have to interacting in novel ways for users. Also, participants Tilde and Christina used non-psychological but design-relevant language to characterise the heuristic. For heuristic #5, 'include surprising rewards', participant Tilde characterised it as *motivation*, or rather the motivating aspects of rewards. Participant mentioned design-relevant language as 'gamification' for her characterisation, which resembles well to the building of habits through rewards.

In summary, no distinctive mischaracterisations were found from the panel of participants, indicating that the heuristics do appear to accurately reflect respective cognitive phenomena.

Focus group discussion
Looking at Table 4.2 mapping the main points extracted from the focus group discussion, a general consensus among participants also existed in quite a few instances. Although the aim of a focus group is not necessarily to look for consensus, the instances that are provide a more solid foundation for making revisions.
The findings from the discussion that appear the most viable in terms of enacting as starting grounds for changing the heuristics have been made bold. These were both expressed by more than one participant, and at the same time they appear to reflect what generally does not work, and what does, about the format of the heuristics.

In short, (1) their intended value seems to be currently well-reflected, (2) the chosen number of included heuristics seem to 'just right' in terms of giving adequate but not excessively much information at once, (3) the concept of fast/slow thinking might need refinement, and (4) the visual presentation of the heuristics do not support readability. Point (3) and (4) will be grounds for an interaction of the heuristics going forward.

4.2. Initial Inquiry activity #2 - Focus group with expert design practitioners from DesignPeople

The first of the Initial Inquiries consisted of a preliminary validity assessment of the heuristics. Additionally, a discussion amongst participants yielded important points for iterating the heuristics and their overall presentation.

4.2.1. An argument for choosing not to iterative heuristics in-between Initial Inquiries

The heuristics are chosen not to be changed in-between the first and subsequent Initial research inquiry with DesignPeople. The decision not to do so is based on three arguments. First, (*i*) the opinions voiced by the design psychology students are being combined with those of the practising experts at DesignPeople, in order to better get a sense of potential diversity in opinions. This is also reflects a striving for saturation as advised by Morse et al (2002), when different subjects review the same rendition of heuristics. So, rather than letting the 'product' change, the type of participants do. Second, (*ii*) since the none of the heuristics seemed to synthesise design-relevant cognition knowledge in an invalid way, the present heuristics are deemed 'good enough' to not immediately iterate on. Put differently, the heuristics at their core seem to be solid enough that the practitioners of DesignPeople can evaluate them accurately in terms of their content, as they presently are presented. Third, (*iii*) due to scheduling constraints the focus group with DesignPeople had to be booked soon after the first Initial Inquiry had taken place, thus allowing little time to make any adjustments thoroughly reflected.

Of course concerns for this approach exists too, mainly being unable to produce as high a potential for the heuristics when finally testing them with the target user, due the loss of one round of iteration. However, with the decision to let the heuristics stay the same, the second Initial Inquiry with DesignPeople will be conducted with the aims of (a) further collecting opinions on the heuristics, as they presently are, and (b) to evaluate method of investigating the experience using the heuristics.

4.2.2. Main purpose of the research activity - gathering expert practitioners' opinions, and pilot testing the procedure for testing the use of the heuristics

DesignPeople pose an interesting demographic in terms the heuristics. While the heuristics are designed explicitly with novice designers in mind, and DesignPeople

in no way constitutes novice designers, the experts practitioners all have the experience of going from novice to expert. This makes it possible for them to reflect upon hard-earned lessons and experience, trying to work with usability, while being able to pin-point those experiences to different phases of the design process. In extension, it makes it possible for them to consciously reflect upon the use of the heuristics in terms of how they contribute to specific aspects of a design process.

The purpose of the second Initial Inquiry with DesignPeople is thus only partly to get more diversity in opinions about the heuristics when added to those of the design psychology students. It is also a viable opportunity to get reflections on the use case scenarios for the heuristics, and furthermore to get feedback on the research methods for investigating the use when later recruiting novice designer participants.

4.2.3. Methodological considerations

Like with the prior Initial Inquiry this activity is chosen also to be conducted as a focus group, though for much different reasons. With the prior Initial Inquiry, utilising a modified focus group agenda, the first and foremost aim was to get a preliminary validity assessment of the heuristics. This achieved not through a traditional focus group discussion, but rather through the beginning individual assessments, which were then shared and made possible to comment on by the participants. Then, the following focus group discussion aimed to get feedback on the overall presentation and communication of the heuristics. This was thought an appropriate opportunity to utilise a moderated group discussion, as typically done in focus groups. To sum up, the prior focus group was modified to accommodate individual assessments.

With the following Initial Inquiry with Design People, the reason for choosing a focus group method, and one that is more traditional in its execution, is two-fold. First, focus groups in the UX realm are often conducted with the purpose of getting a diverse and honest set of attitudinal data about a product, which is presented or handed over to participants to try. This is very much the purpose of this focus group - to gather expert practitioners' opinions, where the experts can work as a team.

Second, a focus group is chosen for this Initial Inquiry because it serves as testing grounds for evaluating whether or not a focus group method would prove beneficial when conducting the Main Study with novice designer participants. Since the Main Study aims to test the heuristics being used in a natural context, meaning the concept-creation and -evaluation phases of a design process, part of

the natural context consists of conducting the study in a way that reflects real-world design processes. For all designers, but novice designers in particular, this most typically means going through concept creation and evaluation phases in groups. Group working is natural to designers, since the ethos of design thinking is to develop a lot of ideas before narrowing down, and this wealth of ideas is more easily obtained in groups, due to the ability to avoid cognitive fixation by getting inspired by others' ideas (Nijstad & Stroebe, 2006).
Since the Main Study will include design activities performed in groups, utilising focus groups for the Main Study will be a natural extension of the already existing group discussion. And, as Dawson, Manderson and Tallo (1993) advocates focus groups fit the best as research method for target group communities where group discussions are already a natural form of communication (p. 6). Hence, focus groups seem to be the research method the most suited for the Main Study, and is therefore chosen as the method for the testing grounds that is the second Initial Inquiry.

Concerns about conducting the focus group virtually
Due to current COVID-19 restrictions this focus group will have to be conducted virtually, via Microsoft Teams. For this activity several concerns consists, regarding having to conduct it virtually. Namely, (*i*) the success of a fluid group conversation depends on the internet connections of each participant, (*ii*) the moderating role might become more difficult to manage, due to the lack of non-verbal cues that facilitate participants taking turn, and that (*iii*) the limitations of a virtual conference room might decrease the spontaneity of a well-functioning focus groups (see e.g. Tuttas, 2015).
Nevertheless, potential and unforeseen benefits might exist as well, and the restrictions allow no different than to conduct it virtually.

Creating design problem cases that allows for natural-like use of the heuristics
An important consideration for the focus group with DesignPeople is to create some sort of context where the use-case of the heuristics would be naturally fitting. This is to let the participants have a better foundation for experiencing the applicability of the heuristics, and thereby better conditions for evaluating and critiquing them.

Since the heuristics are created with the concept-creation and -evaluation processes in mind, it is fitting to create a context reflecting those parts of an overall design process.

Two approaches to this were considered during the preparations for this Initial Inquiry.
The first approach would be to maximise the ecological validity of the Inquiry by letting DesignPeople adopt the heuristics in actual concept-creation and -evaluation processes, happening in current client projects. This would resemble how the heuristics are intended to be used - pulled out when designers see the need, used as one pleases, enacting as inspiring guidelines rather than strict rules to follow. However, for one it would have to fit timely into the project schedules for finding fit for a fitting project phase, which at this time is deemed unfeasible. Due to the collaboration with DesignPeople this would be entirely possible. Also, since the COVID-19 restrictions in place has stalled all face-to-face project work at DesignPeople, using an actual project would not necessarily be representative of general concept-creation and -evaluation phases on design projects anyway, since these are typically conducted with a team in the same room.
But a more important drawback, this approach emphasising ecological validity would render it impossible to an identical context for upcoming Main Study. In other words, by choosing to let DesignPeople test the heuristics on an actual, current project of theirs that project will not be possible to be used, when conducting the Main Study. The Initial Inquiry will not enact as testing grounds for the Main Study, at least in terms of ways the heuristics are actively applied.

The second approach, which is the one being adopted, is to opt for a less ecologically valid, but more replicable testing context. Here, I will create some case scenarios that includes concept-creation and evaluation, in which the heuristics can be applied trying solve certain design activities. These contexts will be deemed ‘design problem cases’, and the aim is to have them allow a natural-like applicational use of the heuristics. The design problem cases can then be tested in the Initial Inquiry and iterated, or used as is, again in the Main Study based on the findings from initially using them. Due to the emphasis placed on getting the most out of the Main Study, this approach seems to fit the best.

In short, the design problem cases will pose scenarios in which ideating and evaluating concepts are the main tasks. Two cases were made for this focus group, named *Activity 1* and *Activity 2*. The aim for these was for them to be understandable and accessible to both the expert practitioner participants in this focus group and to the novice designers in the Main Study as well. This meant creating cases that provide clear explanation of the case problem, as well as intuitive instructions of how to approach the case problem through a set a tasks to be done. For both the activities, this meant first explaining the contextual *background* of the case problem. Here, I had the creative freedom to make up a

design problem case, as if it had been a client proposal inviting to be worked on. The

Activity 1 - A digital assistant for the traveller, during the reopening of CPH airport, seen in Appendix (4)., is a design problem case in the realm of service design. Here, the participants are asked to help CPH Airport create a digital assistant to help travellers keep distance to one another and safely getting from arrival, to check-in, to boarding, to departure. A set of requirements for the digital assistant are provided to help align the participants on overall design objectives. However, no service specifications are mentioned, in order not to limit creativity in terms of communication and product channels.
Lastly, same for both Activity 1 & 2, the participants are devised to first use (a) 20 minutes to **ideate** concepts for this digital assistant. Here, they are free to include the heuristics however they see fit for ideation. After that there will be (b) 10 minutes to **evaluate** the concepts, in terms of the likely usability and user experience. Likewise, the participants are free to include the heuristics however they see fit for the evaluation of concepts.

Activity 2 - An induction stove with a built-in extractor hood, seen in Appendix (5), is a design problem case in the realm of product design. Here, the participants are asked to help Philips design a modern induction stove with an integrated extractor hood, where both stove and extraction hood settings are easily accessible even during demanding cooking sessions. Identical to Activity 1, a set of requirements for the product user interface are provided to help align the participants on overall design objectives. Also, no product specification are mentioned, and the participants have a (a) 20 minute ideation session, followed by a (b) evaluation session.

For both activities comprising the design problem cases the underlying research aim is not to evaluate the created concepts, but rather the participants' ways of, and experience with, using the the heuristics.

4.2.4 Participants

For a typical focus group five to seven participants are recruited. During conversations with the DesignPeople contact persons for the project internal recruiting was possible, finding an appropriate amount of design practitioners available. Five employees participated, which is enough to facilitate group discussions, while also allowing ample speaking time per participants (Debus, 1988).

4.2.5 Procedure

The focus group procedure will be inspired by Debus (1988), who advocates the agenda being split into four phases. These are, in chronological order, *opening*, *warm-up*, *discussion*, and *closure*. A significant adjustment being made to this proposed procedure is to substitute the warm-up with an *activity* phase. The warm-up phase is usually placed to get unacquainted focus group participants familiar with one-another. However, since all participants in this Initial Inquiry are coworkers, this makes little sense. Instead, the phase will be one where participants get to use the heuristics in setup case design problems. Below the procedure for each phase will be explained. For a view of the interview guide used to moderate the focus group, please see Appendix X.X. It should be noted however, that the interview guide acted as a general guideline, while allowing for ample interpersonal discussions around the moderating topics.

Opening the focus group, the participants were first greeted into a virtual Microsoft Teams video conference room and thanked for their participation. Next, the participants were given a verbal introduction to the purpose of the focus group. Next, a brief agenda for the activity was given, in order to give participants of where they were in the activity in terms of process. Then, the intended use for the heuristics were stated, including the target demographic for which they are designed. This would normally be left out as it could unwittingly lead participant opinions. However, since it can help the expert practitioners reflections and evaluation of the heuristics, it was purposefully included.

For the ***activity*** of the focus group, the participants were informed that they would first be presented the heuristics. After that, they would go on to participate in the set up case problems. The heuristics were shared as a PDF file over the Microsoft Teams chat function so that each participant had the opportunity to read them through individually. The participants were given five minutes, which through observing reading times in the prior Initial Inquiry is deemed more than enough time, in order to not let the completion of one participant stress or rush the another. The participants were given the opportunity to ask any clarifying questions concerning the heuristics and their content.

After everyone had read the heuristics, they were then informed of the nature of the upcoming design problem cases, i.e. Activity 1 & 2, where the heuristics can be actively applied. Activity 1 was then read aloud, and the participants were told that they could ideate and evaluate during exclusively over Teams, or alternatively by using software aiding online collaboration of their choice. This was not pre-

specified, since DesignPeople likely have their own preexisting ways of engaging in online concept-creation and -evalution during the pandemic.
A timer was set for 20 minutes for ideation, and 10 minutes for evaluation. Participants were allowed to use a little longer to reach a natural conclusion to their activities.
After Activity 1 had been conducted, the participants were instructed to carry on with Activity 2 in the exact same manner.

A 15 minute break was scheduled after the completion of the activities, in order to break up the overall 2-hour agenda, and allow the participants to clear their heads, before commencing the next phases.

For the ***Discussion*** phase, the participants were welcomed back after their break. The preceding focus group phases were summarised, in order to make a transition onto the discussion about their experiences using the heuristics during problem-solving. The participants were reminded that the desired outcome of the discussion is not to have a question-and-answer interview between me, the researcher, and them individually. Rather, they were encouraged to engage in a dialogue with one another, build on each others' statements, voice disagreements, and in general speak without too much constraining deliberation.

The discussion was moderated by a few overall questions. These are listed in a condensed order in the below Table X.X. For the questions in their full versions, please see the Focus Group Interview Guide in Appendix (6).

Table 4.3.

1. *Did any of you experience problems during the Activities? If yes, were any problems related to the use of the heuristics?*
2. *How was it to use the heuristics in the proposed Activities?*
3. *Going through the heuristics from first to last, did any cause confusion?*
4. *How did the heuristics (individually or collectively)* ***help*** *or* ***hinder*** *you during concept-creation?*
5. *How did the heuristics (individually or collectively)* ***help*** *or* ***hinder*** *you during concept-evaluation?*
6. *On a general level, let us talk about the use of heuristics and value of heuristics, including mine. How do you see that heuristics may/may not add value?*

For the ***Clousure*** phase, the participants were asked if they had any burning remarks, comments, questions, or critiques - either pertaining the prior Discussion questions, the topics that evolved from the dialogue, the focus group procedure as a whole, or about the overall thesis project and its aims. Most importantly, the Closure phase was also used to ask for feedback on the proposed research methods for the upcoming Main Study.

At the very end the participants were once again thanked for their participation.

4.2.6 Results

The focus group was recorded with both video and audio. In order to process the data resulting from this Initial Inquiry a procedure of (a) transcription and (b) interpretation, which both will be explained in-depth below.

The first effort in processing Focus Group interview data is to make a transcription of what is being said. Different ways exist of doing so, herein a *full transcription, meaning-condensation* etc. These methods also include varying ways transcribing non-verbal or…. These methods differ both in the time and resources they take to carry out, but also in the degree of which the data is processed. For example, with a full transcription the data is more 'raw' and unfiltered than through meaning-condensation, where important points may have been (un)purposefully excluded in the transcription (REFERENCE to TechFestival and…)

Full transcription, using Otter.ai

Chosen for this transcription is to utilise an artificial intelligence transcription service, called Otter. The paid plan of Otter makes it possible to upload a audio/video file and via language processing algorithms the software is able to (a) create a *full transcription* of the entirety of the discussion, (b) include timestamps, (c) identify each individual speaker through voice recognition, and (d) highlight the most common descriptive words through either a list of keywords or via a word cloud visual representation (Otter.ai, 2020; Su, 2019; Adams, 2019).

Though Otter.ai make not claims in terms of its transcription service accuracy, i.e. the amount of words or utterances correctly transcribed out of all that is being said during an interview, several authors found an accuracy around 98-99% (i.e. Son et al, 2020; Sheridan, 2020; Blechhynden, 2020).

Ultimately, the decision to trust the transcription service was based on two verification efforts. First, I took two random 10 minutes samples of the focus group interview and listened through the recording, whilst checking for transcription errors. For the total of 20 transcribed minutes, only three errors were found, and

they all consisted of indistinct utterances without any semantic meaning. Next, through the indexing of the interview, described below, bits of the interview was played back, while making sure that important points on the transcription corresponded to the actual words being uttered. Here, very few flaws were found, and the transcription always conveyed all semantic meaning. For these reasons, I felt comfortable using Otter.ai. The focus group transcription can be seen in Appendix X.X.

Indexing data through subtopics

To make sense of the interview data, it was chosen to *index* the transcribed conversations, as inspired by Krueger (1994) and Yin (2011). This essentially means coding the subtopics of interest via indices such as numbers or letters, and then mark pieces of conversation that corresponds to, or is relevant for, the given subtopic. The sense making of indexing is further helped by creating a table, or matrix, of the interview results through these indices, as advised by Yin (2011, pp. 191-199).

On Table X.X is a summary of how participant points aggregates across the made up indexes. The table showing the indexes only can be found in the focus group transcription, in Appendix X.X.

For the tables below, the only important thing to note is that each subtopic is indexed via letters. If a point by a participant includes opinions, or comments, on a specific heuristic, out of the five presented, then those are specified via the heuristics-specific columns.

Heuristics	**Non-specific to a heuristic**	**#1 'Limited Attention'**	**#2 'Maximise/ satisfise'**	**#3 'Recognition over recall'**	**#4 'Work with habits'**	**#5 'Include rewards'**
Codes						
Overt use of specific heuristic		1			1	1
General opinions on use case	8					
Heuristics helped concept creation	3				1	1

Heuristics	Non-specific to a heuristic	#1 'Limited Attention'	#2 'Maximise/ satisfise'	#3 'Recognition over recall'	#4 'Work with habits'	#5 'Include rewards'
Heuristics hindered concept creation	3	1		1		
Heuristics helped concept evaluation	1					
Heuristics hindered concept creation						
Overall thoughts on using heuristics (not only mine)	5					
Target group	3					
Methodological concerns	3					
Personal descriptions of one's normal ways of working	10					
Critiques (on the formulation/ communication of heuristics)						
Praise (on the formulation/ communication of heuristics)	1					
Other						

4.2.7. Analysis

General first observations

As can be seen from Table X.X an eye striking find is that most cells are empty. This is primarily due to the lack of heuristics-specific comments, i.e. participants attaching a comment on e.g. the value of how heuristic #4, 'Work with habits', is formulated. Even though most moderating questions were asking generally about the experience using the heuristics, one presumption was that the participants

would attach comments to specific heuristics via the developing group discussions. As seen, this presumption has been proven wrong.

Another general observation is the skewed distribution of answers across subtopics. To discuss the use of heuristics in general participants largely used anecdotes to put the present heuristics into some sort of perspective. Therefore much of the points made were referencing participants own prior work.

A third observation from the table is that the majority of points made were with respect to the heuristics used during the 'concept creation' phase, rather than the 'concept evaluation' phase. This may be because of the heuristics being more or less applicable for one phase over the other, as discussed in the analysis shortly, but it likely may have to do with the fact that the participants did not spend much energy evaluating their concepts, as intended through the moderating interview guide. In other words, it proved difficult for me as a moderator to maintain a focus amongst the participants to stop creating concepts, and second to start and continue evaluating their concepts.

Finally, the amount of times participants overtly used the heuristics during Activity 1 & 2 were very limited, as seen in the table. In other words, the heuristics were seldom mentioned by the participants during problem-solving. This does not necessarily mean that they were not used at all, although it could, but it does show that the heuristics did not enact as topics of conversation amongst participants during concept creation and evaluation.

Prevalent themes, for using heuristics during 'concept creation
The following present section will dive into the findings from the focus group.

A consensus amongst participant Jonas and Adam existed in that they found the heuristics non-useful for the divergent concept 'creation' phase. They felt self-sufficient in engaging in divergent thinking without external aids (Jonas & Adam 1:20:20). Adam attributed this self-sufficiency during the creation phase to his experience as a practitioner (1:23:11). Salem on the other hand found the heuristics to enact as "*mindsets*", useful to have in mind throughout the entirety of the design process. Stating further that they help reminding, "*we don't have to invent the new thing here, we already have some existing habits and behaviours that we can work within. And I think some of these five thumbs are great mindsets to have throughout the entire design process.*" (Salem, 1:21:30). Adam stated that the heuristics do benefit the concept creation phase in terms of helping avoid idea fixation and feeling stuck (1:21:30).

Additionally, a key benefit of the heuristics seemed for Adam to be that they formalise a shared structure for evaluating concepts, across a team with interchangeable members of varying levels of experience. He states, "*Because sometimes.. ..you have that* [those usability principles] *in your mind, you, you maybe don't give it enough focus or you kind of it's, it doesn't get as much attention as it should be. So it's a good way maybe, to force yourself always to think about these things, and formalising it is a way of doing it and making a method about it.. ..*[Also,] *when team changes all the time, so you have other people you collaborate with, and it's good that you that everybody has, has kind of maybe a similar framework to work from. And there are new employees coming in just like that. So it makes sense for me having a more formalised structure.*" (Adam, 1:54:55)

Salem speaks into the heart of how he sees heuristics in general being used, realistically. He states that the 10 guidelines by Norman are pieces that he does not remember in terms of their content, but that they work as checklist to evaluate one's product through (1:56:14).

Reflections on the formulation/communication of heuristics

A valuable area of input from the focus group is the expert practitioners reflections on the heuristics themselves, in terms of how they are formulated and what they aim to communicate.

A finding in this area has been one practitioner stating a need for contextualising (some of) the heuristics, in order to better apply them. By contextualising them it is meant that the heuristics, which as stated by now portray general rules-of-thumb from user cognition research, may feel difficult to use if not specified to the restrictions of a given design brief or user demographic. Salem states that heuristic #1, 'limited attention', is a difficult to apply without knowing more contextualised information about exactly what limited attention refers to, and how to design with this in mind. "*I think number one would be easier to use if you had more like a specific user profile. So you kind of specify a robot? Yeah. So we should make this one of these tasks and say, Okay, we have this persona, female person this age, work with this or has many kids, then you also can easily imagine how our everyday life is and how the limitations of this specific persona is, then I think the number one rule of five rules from some of us would be much easier to to apply.*" (Salem, 1:26:32). The other participants agree that personas give context to work with, in terms of usability (1:27:32).

The voiced opinions about some of the heuristics being 'broad' in terms of what they describe seems specifically in regards to ideating off them, or being inspired towards creating new (parts of) concepts (1:25:57).

In terms of communication, Adam also went to argue that their teams previously have had success with heuristics by having them printed on boards and having them displayed physically in the room. That way, they were more impactful (1:58:27).

Participants' input to methodological concerns
Another valuable area of input from the expert practitioners consists of methodological considerations made, in terms of how to test the experience of using the heuristics. Here, because the participants are design practitioners and researchers as well, their considerations lie on experience testing products (in this case, the heuristics) themselves.

Jonas suggest for researching the use of the heuristics in a group setting to have one participant be the 'master', or owner, of the heuristics. That way, the team evaluating concepts can be guided by the one responsible for the heuristics to go through each heuristics one by one (Jonas, 1:33:30). Adam contributes to this idea of a rule-based application of the heuristics, advocating for brainstorming concepts e.g. 10 minutes at a time using a given heuristic as a point of departure. Because, as he said, "*maybe we were brainstorming and then you skipped some of these.*" (Adam, 1:34:27).

Author reflections on the learnings from the focus group Initial Inquiry
Conducting the focus group with participants from DesignPeople was fruitful, both in terms on the input from participants, and in terms of evaluating the research activity itself.

In terms of reflecting on the findings from participants summarised above, few notable things stood out. First, the heuristics seemed to both (*i*) hinder free-flowing concept creation, but also (*ii*) enable it to some degree, in terms of participants overcoming fixation during the divergent parts of Activity 1 & 2.

More importantly, and detrimental to the learning outcomes of the focus group, has been the lack of any substantial concept evaluation. Though it was prioritised as topic in both the Activity task descriptions and the subsequent moderating interview guideline, little focus was actually put on this topic. A learning outcome here is to be more stringent in the enactment of moderating the Activity phase for the Main Study to ensure that all tasks are properly worked on.

Lastly, reflecting on the quantity and quality of the data from the focus group being conducted virtually is important. This is to effectively utilise the Initial Inquiry as testing grounds for how to conduct the Main Study, as described. The overarching impression is that the virtual focus group format has some substantial drawbacks for acquiring 'enough rich' data for this particular Main Study project. The typical benefits of a focus group, i.e. facilitating a rich intergroup conversation, seem to be not as beneficial for this present study, where it is the participants' understanding of the heuristics that matters most. Reflecting from this prior focus group, it seems that gathering five participants online makes it harder for me as a moderator to probe for participants understanding than with individual interviews. And precisely, the role as a moderator is not to repeatedly interfere with a ongoing group discussion, but rather to facilitate that discussion with only minor adjustments (*Reference*). And, because participants do not seem to easily give away information about their understandings of the heuristics, a focus group seems to be ill-suited for the Main Study purpose. This is a reflection on the 'quality' of data from the Initial Inquiry. Additionally, an argument in opposition of a focus group would be the reduced 'quantity' of statements given in a single 1,5 hour focus group, versus five to eight individual 1-hour interviews. Looking at Table X.X, only a total of 44 clear statements were obtained during the focus groups, clustered around specific subtopics. It is likely that opting for a research method utilising the participants and the time they have been recruited for will prove beneficial. This could for example be a series of individual interviews, which would yield not only more useful data in terms of participants' understandings of heuristics, but also larger quantities of useful data.

The commencing Main Study has the overall purpose of investigating the thesis project's problem statement, drawing on the learnings from the two Initial Inquiry studies to best proceed in this investigation. Essentially, the Main Study aims to take the latest iteration of heuristics and test them with a representative group of novice designer participants, using a research methodology refined over the Initial Inquiry.

4.3.1 Overall research purpose

The Main Study is conducted to *help* answer the thesis' problem statement. Although it can be seen as the 'main experiment' of a typical project, where the Initial Inquiries enacted like pilot experiments, the Main Study is not conducted with the intent of being the *sole basis* for answering the thesis' problem statement, which will be mentioned once again, for good measure:

"In which ways can Dual Process Theory operationalise as a heuristic for user cognition amongst novice product designers, during concept development/ evaluation?"

Rather, the Main Study will be the an empirical way of investigating the heuristics that were derived through theoretical investigation. As such, the theoretical and empirical investigations will be joint, when trying assess in which ways DPT can operationalise as a heuristics for user cognition amongst novice product designers.

The overall need leading to conduct the Main Study is to take the theoretically derived heuristics and study the experience of novice designers using them, in order to evaluate both their (*a*) informational and (*b*) applicable value. Second, it is of interest to probe for the effect DPT might have as a framing heuristic, across the five guidelines/rules-of-thumb.

4.3.2 Final methodological considerations

The methodological framework for investigating the potential value of the DPT-framed design heuristics remains similar to that of the second Initial Inquiry, i.e. the focus group. Though a few substantial negatives were found for that research design, as mentioned in the prior subsection, these can likely be negated through some methodological changes. The changes made will be presented and discussed in this present subsection. For easy reference is below an exhaustive list of the changes made:

1. The novice designers will be recruited to *individual interviews* rather than one or two focus groups.
2. All interviews are designed the same way with their respective phases, and an estimated duration of 60 minutes.
3. Only the created Activity 1 case problem will be reused for the interviews, instead of using both prior case problems.
4. During Activity 1 participants are instructed in engaging concurrent TAVP, which will be 'interactive' through somewhat moderator engagement.
5. The design heuristics used will be the iterated version, where the readability and visual appeal has been worked on.
6. A new interview guide is created to suit the aims of the Main Study, alongside the fitting the target audience of the participants.

The list of changes made from the second Initial Inquiry to this present Main Study will be discussed below through the methodological considerations behind them.

From focus group to individual interviews
As indicated in the author reflections section just before, Section (4.2.7), the found inadequate amount and richness of data from a single focus group with all participants leaves a need for another research method than a focus group. This is to make the most of the participants, and the time with them, that are recruited, seeing as recruitment is labor-intensive.

The as the need for asking probing questions about statements and attitudes seems crucial to gain data on participants' experience with, and of, the design heuristics some sort of interview format seems appropriate. And, contrary to a focus group interview style, the possibilities for probing for especially attitudes as an interviewer rather than a moderator seems more likely. This is so, because for especially individual interviews the interviewer can help construct knowledge through a dialogue 'inter-view', or in-between', the two persons (Brinkmann & Kvale, 2015, p. 37), even if that interview is closer to a *semi-structured* than a *unstructured* type (Dewalt & Dewalt, 2002, pp.137-142; Zhang & Wildemuth, 2009, pp. 223).
With the research goals in mind, individual interviews will be the ongoing foundation, when proceeding to iterate the research design for this Main Study.

A common structure and guide for all interviews
When conducting individual interviews nothing keeps the researcher from changing one's interview guide, or interview type, based on the knowledge from prior interviews. This might be especially useful if the research aims to uncover an underlying social phenomenon, where the insights from one participant might help steer the direction of a subsequent interview. In these cases the researcher may be hindered by sticking to the same semi-structured interview guide (Dewalt & Dewalt, 2002, pp. 142-43).
However, for the interviews of this study the personal understanding and experiences in question will likely be able to be probed for with the same starting points for conversations. In other words, it makes good sense to make use of the same semi-structured interview guide for each interview, where the guide takes its starting point in Activity problem case and from there asks some *open-ended* questions to get the participant start reflecting on his/her experience. Subsequent *follow-up* questions can then create openings to better inquire about e.g. conflicting statements that ultimately helps shed light on participants understandings and experiences (REFERENCE?).
A common structure and interview guide has the additional benefit of providing grounds for a mostly *deductive* style of coding data during the data analysis later on. Here, since every interview touches on the same fundamental topics of inquiry,

and the knowledge of interest for the Main Study is known beforehand, the main findings can be more easily extrapolated via the constant, semi-structured interview type and a corresponding deductive type of coding data (REFERENCE?).

Lastly, typical to individual interviews of such a character, the duration will typically be shorter than that of a focus group. The focus group was estimated to run for two hours, and the individual interviews will more likely be half of that with a well-structured interview, which benefits both participants and me as a researcher in terms of timely resources required.

Reusing only Activity 1 for participants to apply design heuristics
Based on the experience of facilitating the focus group, it seems like only one Activity will be sufficient for allowing an individual to apply the design heuristics. Rather than trying to apply the heuristics for different case problems, one very fitting and straight-forward case, with ample time allocated to it, is deemed appropriate. Such a fitting and straight-forward case is believed to be found in Activity 1, the service design case about the digital assistant for travellers at CPH Airport. This Activity lends itself to concept creation and concept evaluation, where the concepts can go in many directions, while still being within the boundaries of the case. The case is also well-suited to the target group of the Kaospilot participants, who seem to be more comfortable in service design than product design, based on the descriptions of the education (Kaospilot, 2021). The Activity also proved immediately understandable in the focus group, with no need for clarifying questions and no observed misunderstandings. The one exception was the lack of commitment to the concept evaluation task, which will be circumnavigated in the Main Study through clear verbal restatements of the written instructions for each Activity task.

Utilising interactive, concurrent Think-Aloud Verbal Protocol (TAVP) during Activity 1
One significant consequence of moving from a focus group method to individual interviews is the lack of interpersonal communication during the Activity tasks. In other words, since there is no longer a group with members sparring with one another, the individual concept creation and evaluation tasks will now be performed alone. It is quite likely the default of the Main Study participants is then to work in silence, unless otherwise instructed. This makes it difficult to extract any information of a participants' considerations during the engagement of tasks, outside of sheer observation. Additionally, the silent task engagement may be difficult for the participants as well, since most typically create and evaluate

concepts during interpersonal discussions and collaboration, and thus the atypical scenario may be negatively influencing their experience.

In order to maximise learnings during the individual interviews, and to help avoid an uncomfortable scenario for the participant, Activity 1 is chosen to not only pose as starting grounds for the following focus group discussions. Wickens, Gordon and Lee (1998) describe three methods for gathering data during participants interacting with a product, here being the proposed heuristics, during problem solving. These are O*bservation, Task Performance with Questioning* and *Think-Aloud Verbal Protocol (or, TAVP)* (Wickens, Gordon & Lee, 1998, p. 60).

The first-mentioned Observation method, where the researcher observes user-product interactions, would be a seemingly bad fit for this Main Study. Seeing as the heuristics are merely pieces of information, the use of them during problem solving will most likely not results in clear behavioural data that allows for such interpretations. For this reason, using Observation to gain data on the experience of using the heuristics is not further considered.
The second method, Task Performance with Questioning, involves asking set probing questions to the participants, meanwhile they are interacting with the product. This has the advantage of cueing participants to verbalise exactly what is asked of them, such as underlying interaction strategies, rather than merely what goes through their head at the moment. The main disadvantage is however the risk of disrupting their flow of interaction with the product and their problem solving using the product. Because set questions already exist in the subsequent interview discussion, this method is seen as too intrusive for its intended purposes.

The third method, Think-Aloud Verbal Protocol (TAVP), seems to have the desired degree of probing to extract more data than using no data gathering at all during the Activity, but not to a level where the added task will disrupt the participants workflow significantly. In fact, a study found TAVP, i.e. think-aloud simultaneously cooccurring with problem-solving, to have little influence over participant behaviour and mental workload during problem-solving, compared to standard non-verbalised problem-solving (Hertzum, Hansen & Andersen, 2009). For these reasons, concurrent TAVP will be implemented for the activity-part of the interview.

One possible methodological adjustment to the concurrent TAVP will be to use what Zhao and McDonald (2010) defines as I*nteractive Concurrent TAVP*. Here, the researcher will communicate with the participant during problem-solving. This enables the researcher to help the participant should any problem arise, and it facilitates an even flow of verbalised thoughts. Moreover, and specifically thought

useful in terms of this Main Study, the Interactive version of Concurrent TAVP helps establish a more down-to-earth atmosphere during the activity, so as the participants does not feel evaluated by his/her performance during the problem-solving (Zhao & McDonal, 2010, p. 587). This is deemed especially important during the research with novice designers, who may feel slightly uncomfortable trying to problem-solve both (a) individually and (b) virtually. Precautions for this method will be made, as not to distract the participant with chatter, or as to nudge them into certain answers while communicating. But overall the potential benefits of Interactive Concurrent TAVP makes it a focal point for facilitating the Activity during the Main Study.

Creating a new interview guide, being precautional about the '*mom-test*' *bias*
For the Main Study an interview guide must be carefully constructed to achieve the foundation for interviews, where data constructed is relevant for the identified knowledge outcomes. These are, once again to evaluate the design heuristics in terms of both their (*a*) informational and (*b*) applicable value. Second, it is of interest to probe for the effect DPT might have as a framing heuristic, across the five design heuristics.

The interview guide will base its questions about the experience of using the heuristics as a tool during the concept creation and evaluation tasks of the Activity. Since the setting for these individual interviews are virtual, an emphasis during the preparation of the interview guide will be put on not only the *thematic dimension* of the questions, i.e. the content of the questions, but also the *dynamic dimension*, meaning the reflections about how the structure and flow of the interview affects the interpersonal relationship between the interviewer and interviewee (Brinkmann & Kvale, 2015, pp. 156-57). The emphasis will be on creating a welcoming atmosphere to circumnavigate the perceived impersonal coldness of the virtual setting, alongside the power relation of me as an interviewer being potentially being view as one, who judges or evaluates their creative process during the Activity.

Additionally, a reflection constructing the interview guide and preparing for the execution of the interviews will be to continuously attempt to clarify the meanings comments made by a participants that appear immediately relevant to the desired learning outcomes for the Main Study. This is recommended for researchers, who contrary to a grounded approach already knows the main points of interest for an interview (Brinkmann & Kvale, 2015, pp. 159-60), which is the case for this Main Study. This could e.g. include seemingly telling participants comments about their

frustrations or joys using the design heuristics in any of the Activity tasks, or about the fast/slow language that is used throughout the heuristics.

In terms of using the interviews to evaluate the heuristics should pose a potential cause for concern. This is so because asking well-meaning participants what they think of a product, particularly one interviewer has created himself, will lead to answers that biased towards positive affect. Fitzpatrick (2014) wittingly coined this phenomenon '*the mom test*', referring to the undoubtedly biased response from one's mom when asking her for honest feedback on a project one has made (p. 8). In Entrepreneurial and startup settings recruited participants will often suffer from this same bias, since the politeness of the participants to not hurt the interviewers feelings will steer their answers to a positive response to the product in question, no matter what they think of it. This is largely because (a) the interviewer is affiliated with, or even the sole creator off, the product. It can also be (b) because the recruited participants are highly motivated 'first-movers' of the intended target demographic for the product, meaning that they will overlook major complaints they have because they like the underlying concept of the product in question (pp. 72-73).
Similar to the mom test phenomenon social science and user researchers also are cautionary about participants agreeing with researcher statements due to politeness and authority, denoted *acquiescence bias* (Sauro & Lewis, 2016, p. 204).

The reason for mentioning the mom test is that I, the author, will be both the creator of the design heuristics, i.e. the 'product' to be evaluated by the participants, while also being the person conducting the interviewer. Even more, the Kaospilot participants have been recruited through my significant other at the time of writing, making the relation between the participants and myself less professional than in an ideal study. Still, the Kaospilot students were chosen, because they are very representative of the intended target demographic for these design heuristics.
The interview guide, and all communication during the recruitment process prior to the interviews, is therefore very much mindful of this potential for bias and will therefore to a great extent apply the advice for sound questioning and probing by mainly Fitzpatrick (2014). Some of the advise is more relevant for proper indications of whether users would buy one's product, which for these interviews are not a concern. The advice applied is listed down:

- Avoid biased data, through..
  -deflecting compliments, i.e. asking specific and relevant follow-up questions, when generic compliments are made (pp. 24-28).

-‘anchoring fluffy comments, i.e. probing for specificity when participants are fluffy or vague in their opinions (pp. 28-33).

- Welcome, and even promote, negative opinions (pp. 42.43).
  -The participants will be repeatedly reminded that I as an interviewer is only interested in the most honest depiction of their experience, alongside any and all negative opinions (please see the interview guide in Appendix X.X at page 1 for examples of such efforts).

Furthermore, Sarniak (2015) advices that to avoid bias in leading questions and wordings by the interviewer by (a) sticking to the same language/wordings used by the participant when asking a follow-up question, and (b) avoid summarising participants’ statements with different words than their own. This might however obstruct the chance for asking probing follow-up questions, which as Brinkmann and Kvale (2015) states is a crucial part of many questioning procedures (pp. 199-200). Therefore, these pieces of advice will be implemented as thoughtfully as possible during the interviews, with judgments about balancing non-leading approaches versus purposefully probing questions that may free up the participant to rethink or elaborate on their opinions in other words.

4.3.3 Participants

As stated, the participants recruited all came from the Kaospilot education, due to being perceived as well representative of the intended novice designer target demographic for the design heuristics, as originally described in Section (X.X - SECTION 1**).

Seven participants were recruited, aged 21 to 27, with an even split of four male and three female participants, respectively.

4.3.4 Procedure

Almost identical to the procedure for the focus group Initial Inquiry (see Section 4.2.5) the overall Main Study research activity will be carried out with a modified version of Debus’ (1988) notion for conducting focus groups. Here, for the individual interviews of the Main Study, the framework still makes sense, in that..

A. , an *Opening* phase will consist of greeting the given participants, and by describing the overall purpose of the study.
B. , a W*arm-up*/*Activity* phase will consist of first presenting the design heuristics by having the participant read them through, and then commence to the created Activity. Here they will be presented the Activity by having me read the

Activity instructions aloud. Subsequently they will be instructed how to engage in TAVP, and they will be reassured that the purpose of the study is only to investigate their experience, *not* to evaluate the output of their creative process.

C. , a *Discussion* phase, where the interviewing of the study will begin, using the constructed interview guide.
D. , a *Closing* phase, where the interview is round off, and participants get to ask questions about the study, clarify earlier statements should they wish to, or add anything they have left.

The interview guide fully showing this framework being utilised is found in Appendix (8).

The entirety of the activity will be conducted virtually through Zoom, as the video conferencing application of choice. Similar to the second Initial Inquiry the concept creation and evaluation tasks of the Activity will be conducting using an online sticky board, this time being the free Miro application (Miro, 2021), for participants to ideate and evaluate concepts at full display for me to follow along. Participants will be asked to share their screen on Zoom to show the work being done on the Miro board. An example of a Participants' work is shown below in Figure (**Readers note, this image became corrupted*), via a screenshot of the Miro session.

After each interview has been completed the participants have been thanked for their participation.

5 GUIDELINES

for designing usable products and services, with human psychology in mind

Everyday life consist of thousands of potential decisions. To help navigate this, people generally use two types of thinking; *fast* and *slow*.

Most of what we do during our day is based on routines and habits, where we can act confidently based on our experience with something similar in the past. Not much thought is given to our decisions and actions. This is thinking 'fast'. It is efficient and our go-to way of thinking.

Sometimes, people may want to slow down and really try their best to solve an important or novel problem, using logic and being in control of thought and actions. This is thinking 'slow'. It feels hard, and our capacity to do it is very limited. All people are capable of both types of thinking. As a designer it is important to have the user benefit from both types of thinking.

These guidelines are meant to help the designer keep fast and slow user thinking in mind, when creating concepts for product designs and services. They are not meant as strict rules to follow, but rather as general sound advise. Once concepts are prototyped, it is highly beneficial to include user-testing.

1. 'MAKE THE MOST OF PEOPLES' LIMITED ATTENTION'

Be realistic about the everyday scenario(s), where your design is meant to be used. You are likely competing for limited attention with other designs and social factors. If you need users to think slow and really take in information, then take away all other information irrelevant to their current interaction.

2. 'MAKE IT POSSIBLE FOR PEOPLE TO DECIDE, BASED ON BOTH LITTLE AND LOTS OF DETAIL'

Not every decision is important to every user. Sometimes, people take the first and best thing, while not wanting to think elaborately about the consequences of that decision. Other times, they will want to go through every detail before deciding. Because some like to think slow, and others fast, designs have toaccommodate both. Show only key attributes of options, with the option to dive into detail.

3. ‘HELP USER MEMORY WITH RECOGNITION, RATHER THAN RECALLING’

> Make the current status and options visible to keep people informed of their options at any given time. The user should not have to remember, or recall, what is possible. It should be visible. This will reduce the load on memory.

4. ‘WORK WITH, NOT AGAINST, EXISTING HABITS’

> If people have a habit of interacting that does not look like what you had in mind, try to redesign your product to encompass that habit. Unless you give users a really good reason, they will think fast and do what they are used to.

5. ‘INCLUDE SURPRISING REWARDS IN YOUR DESIGN TO KEEP PEOPLE COMING BACK’

> Having people consistently engaged with your design is not always necessary, and it can be hard to build a habit that makes people automatically come back. Users will think slow about the pros and cons of interaction, unless you appeal to their fast thinking by including different rewards. Before people have made a habit of your design, they need surprise and excitement to keep coming back. Once a habit is formed, users will be less in need of rewards.

SECTION 5 - RESULTS AND ANALYSIS

In this Section you, the reader, will be presented with the results and the analysis of the Main Study.

The results will first be presented briefly through quantitative methods, in order to gain an overview of the data present.
Then, a series of qualitative efforts will commence. I first engage in low-level initial coding, tagging statements from the interview transcripts with initial codes, all compiled in a self-made *codebook*, i.e. library of codes used. The codebook also contains instructions of how to use the codes, and examples of the codes being used, in order to ensure transparency.
Next, a *reassembling* process begins. Here, I try to create initial categories and refine those categories with appropriate naming and subsequent subcategories.

The reassembling process leads to an *interpretation* process, where I try to make sense of the categorised data by engaging with its content and looking for underlying themes, either across participants or across the previously made categories.

At the end I present those interpretations in a way that leads over to the discussion of the Main Study, in Section 6.

The following section will display the results from the Main Study, as well as an analysis of those results.
Lastly, a wider discussion will be made, where the thesis problem statement will be answered through looking at both the Main Study analysis *and* the theoretical work of Section 2 that has laid ground for the design heuristics being created (Section 3) and tested (Section 4 and 5). Left for the next section, Section 6, is a reflection of the various efforts made for the thesis, alongside reflections of the implications of the body of work, alongside potential for further work on the topic.

5.1 Quantitative presentation of Main Study results

The interviews will first be presented quantitatively, to provide an overview of the breadth of data, alongside preliminary qualitative presentation, before then going into the qualitative analysis.

Of the seven interviews comprising the Main Study research activities, a total of *52.243 words* were uttered, corresponding to *229 pages* of transcription. The interviews had a total time duration of *8 hours and 25 minutes* (SD = 0.17), with the mean, i.e. the average interview time span, being *1 hour and 12 minutes*.

5.2. Preliminary qualitative presentation of results - Indexing interview data through subtopics - Level 1 coding

As with the Initial Inquiries the textual data from these interviews a starting approach to acquiring understanding of what has been said will be done through indexing, or coding, the interview transcripts. This is especially useful in the context of the Main Study, where an interest is taken in any underlying themes *across* the interview participants.

The approach to coding for the Main Study will be mostly *deductive* (see Chi, 1997), otherwise known as *theory-driven* (e.g. DeCuir-Gunby, Marshall & McCulloch, 2011) or *concept-driven* (Brinkmann & Kvale, 2015). In practice this consists of creating codes corresponding to the topics of interest from the interview guide, these initial codes will be created mostly *prior* to going systematically through the interviews. In

essence, they will be created by trying to extrapolate the topics of interest from looking at the interview guide, alongside remembering general topics that occurred during the interviews.
Additionally, once working through the indexing of the interview transcripts, I have opted to allow for the creation of additional codes where deemed needed, in the likely event that the predetermined codes cannot adequately be used to index every relevant statement. This is essentially the inclusion of some *open coding*, or *inductive coding*, where the researcher allows for exploration of the ideas and meaning that are obtained in raw data (DeCuir-Gunby, Marshall & McCulloch, 2011, pp. 139-40). Combining deductive and inductive coding in a so-called *blended approach* can be used deliberately to fit ones research goals (Linneberg & Korsgaard, 2019, p. 265), as is my intention with including open coding, when the predominantly deductive approach falls short.

The onset of the coding process consists of creating a *codebook*. A codebook is a catalog of all the codes being used to index the transcribed text (DeCuir-Gunby, Marshall & McCulloch, 2011). Typically, the meaning of a codebook is to ensure a standardised way of coding for projects with multiple researchers and research-assistants performing the coding. This is done by creating clear descriptors of each code, alongside instructions of how to code. The point of this standardisation is to gain *interrater reliability*, which can then be checked for via statistical testing (DeCuir-Gunby, Marshall & McCulloch, 2011, pp. 149-50).
However, the purpose for creating a codebook for this thesis project, where all work is performed by myself, is to ensure transparency in my ways of working. DeCuir-Gunby et al. (2011) propose a number of ways to create a codebook, in which the descriptors and instructions of each codes affords higher interrater reliability. This process consists of giving each code (a) an appropriate name, (b) a full definition, which includes both inclusion and exclusion criteria, i.e. exactly what *should* and *should not* be indexed/tagged with the respective code, alongside (c) an example from of a statements being tagged with the respective code (p. 138). It is deemed that taking these measures helps to afford a more consist personal performance of coding, alongside ensuring outward transparency of the coding process. And, going back to the seminal Morse et al. (2002) article, these aims at establishing transparency also helps with the 'trustworthiness' of qualitative research (pp. 14-15) (see also Linneberg & Korsgaard, 2019).

An example of one code from the codebook, code 'Heuristics Helped concept evaluation', and its descriptors is included below. For a view of the entire codebook, please see Appendix (9).

CAT1.Heuristics HELPED concept EVALUATION

15 highlights

Statements reflecting how the design heuristics (one in particular, or them in general) helped the participants in partaking succesfully in concept evaluation. This can be instances of opening the participant's scope being focused, facilitating convergent thinking, or helping to assess the potential in one concept over the other. Not used, when the statement is vague or neutral in affect while also lacking any specifics of how exactly the heuristics helped. Example: "like having having those kind of principles to use in evaluating makes it again, like it makes you have a focus to like, in, in what way are you going to judge these ideas? Yeah, that made it easier. I think. Also, if you're like, when when I'm like evaluating my own ideas on my own, it's like good to have some kind of external knowledge or like something that can help me." (Sofie, 44:08).

Figure 5.1. An except of from the Codebook

5.2.1 Resources

Different from the Initial Inquiries the coding procedure for the Main Study is done using an open-source, qualitative research software called Taguette. Taguette is made to aid the labour some process of coding large transcripts, through an intuitive interface where all codes, or 'tags', are ready at hand (Taguette, 2021). One can then filter through the interview transcripts via a certain tag, and the tags can be exported in nifty ways to all file types.

5.2.2 Procedure

The coding procedure follows practices appropriate to the research goals of the Main Study. Theses include the choice to perform *in vivio* coding, the process of coding for.. (). Also, a necessary consideration when coding it the act of '*splitting*' the text apart into pieces. The length of these pieces depend on the type of coding desired. For example, a …. (pp.) requires the act of splitting sentence-by-sentence. However, for this study splitting will be adjusted according to the points made by participants, so this may be sentence-by-sentence, or even paragraph-by-paragraph, when participants make one unified point across multiple statements. It is a pragmatic approach advised by Hahn (2013) as long as it serves the overall research goals (p. 103). This has the benefit of reducing the amount of times needed to code, which decreases the required labour. This is desirable, given the considerable amount of transcriptions, consisting of 229 pages. It also gives the added benefit of affording a more understandable read, when going through the sorted codes, given

that a whole point is not split into multiple less understandable parts. This additionally increases transparency for external read-throughs of the coded transcripts.

One final consideration for the coding procedure has been sometimes, when deemed useful, to include interviewer questions alongside the participants statements in the tagging. This is done either when (a) an answer/statement by itself is considerably less understandable than with a prefacing question, and (b) when a question poses the risk for being potentially leading. As stated in 4.3.2, leading questions can be a necessary tool for probing for attitudes (Brinkmann & Kvale, 2015, pp. 199-200). This choice of including these either leading or attitude-probing questions increases both outward transparency of the interviewing techniques used, while also allowing the possibility for myself to better reassess the validity of a participant's statement, once going through the coded statements, thinking critically about bias.

5.2.3 Results

As with the Initial Inquiries, and as advised by Yin (2011, pp. 191-199), a table or matrix is created to provide a quantitative overview of all the codes used, comprising the codebook. Although the codebook does not correspond to the codes used in the Initial Inquiries, the two-dimensional structure and concept remains the same. The rows consists of the codes used, and the columns consists of the five design heuristics, alongside one column assigned to statements that are non-specific to any one heuristic. This provides yet again the benefit of seeing whether any coded statements (rows) are specific to any/several heuristic(s) (columns). Below is Table 5.2, which shows how the coded statements aggregates across.

Heuristics	**Non-specific to a heuristic**	**#1 'Limited Attention'**	**#2 'Maximise/ satisfise'**	**#3 'Recognition over recall'**	**#4 'Work with habits'**	**#5 'Include rewards'**
Subtopics						
OVERALL Heuristics	34	15	16	17	23	24
General experience during activity (**positive**)	1					
General experience during activity (**negative)**	1					

Heuristics	Non-specific to a heuristic	#1 'Limited Attention'	#2 'Maximise/ satisfise'	#3 'Recognition over recall'	#4 'Work with habits'	#5 'Include rewards'
General experience for **IDEATION**	13					
General experience for **EVALUATION**	8					
Heuristics **helped** concept **CREATION**	23	2	2	3	4	2
Heuristics **hindered** concept **CREATION**	6					2
Heuristics **helped** concept **EVALUATION**	15				1	
Heuristics **hindered** concept **EVALUATION**	2					
Comparing ideation vs. evaluation	10					
Comparison to other tools (**IDEATION**)	9					
Comparison to other tools (**EVALUATION**)	12					
Fast/Slow experience	25					
Fast/Slow understanding	29	1	1	1	1	1
Fast/Slow MISunderstanding	5					
Affect (**POSITIVE**) towards Heuristics	27	2	2	1	2	3
Affect (**NEGATIVE**) towards Heuristics	13	1	1	2	3	2
Format/Communication of Heuristics	19			1	3	
Use-Case (reflections on how Heuristics are used)	14					
Self-Understanding	15					

Heuristics	Non-specific to a heuristic	#1 'Limited Attention'	#2 'Maximise/ satisfise'	#3 'Recognition over recall'	#4 'Work with habits'	#5 'Include rewards'
Other	9					

Table 5.2. Codes fill the rows. Any statements that are tagged using <u>just</u> a code will be tallied using the 'non-specific to a heuristic' column. Any statements that are <u>also</u> tagged to mention a specific heuristic is plotted using the heuristic-specific columns. As seen, most statements are mentioning the heuristics in general, while only a few statements are made with a specific heuristic in mind.

The initial coding procedure gave a total of *300 coded statements*, aggregated across the 20 codes (25, when counting the five design heuristics as codes as well). A whole 256 of those coded statements were pertaining to the design heuristics in general, while the remaining 44 coded statements were specific to one or several heuristics.
Looking at the interview guide, this allocation seems appropriate. The majority of the main questions asked about the experience of the heuristics in a general way, likely leading to the participants reflecting upon the experience with the design heuristics, or 'guidelines' as they knew them, as a whole. There were questions asking specifically about each heuristic, such as *"Let's talk about the individual guidelines for a minute - what did you understand by* [e.g] *guideline #1, Limited Attention?"*. The questions were asked with a series of follow-up questions in mind. I also asked "*Which of the guidelines did you find the <u>most</u>/<u>least</u> useful, if any? Why?"*, prompting participants to discern between individual heuristics. When participants mention specific heuristics it clusters around the codes concerning either (1) whether heuristics helped/hindered concept creation, (2) the positive/negative affect participants have towards heuristics, alongside (3) the format/ communication of the heuristics, to a smaller degree. Otherwise, their reflecting reside in the general realm about the guidelines as a 'set'.

5.3 Analysis, step I - Reassembling the data through coding and reassembling

Typical to larger quantities of qualitative data, coded with a codebook consisting of many codes, the next step is then to take these many smaller pieces of categorised

data and cluster into larger categories, thus focusing the scope the data is viewed through. This is called *reassembling* (Yin, 2015, p. 177), *focused coding*, or *category development* (Hahn, 2008, p. 6). Such reassembling can follow various procedures, but central to whatever choice is that the researcher is deliberate in choosing, and doing so based on fitting the procedure according to what benefits the inquiry of data and overall research goals.

Reassembling may seem like the first proper step in analysing the actual content of the qualitative data, since it involves a larger degree of personal interpretation. However, choosing a strategy for creating codes and tagging the data to begin with, as described above, also involved personal interpretation, even in the case of a less interpretative deductive approach (Fereday & Muir-Cochrane, 2006, p. 83). Still, the starting reassembling involves a larger degree of personal interpretation. For this reason, a **notebook** of the reassembling is created, both to keep track of the iterative process alongside providing transparency over the process. The full notebook can be seen in Appendix (10).

The process of reassembling is summarised in Figure (5.3) below. The Figure attempts to depict not only the steps involved, but also the iterative learning process that causes one step to feed into another.

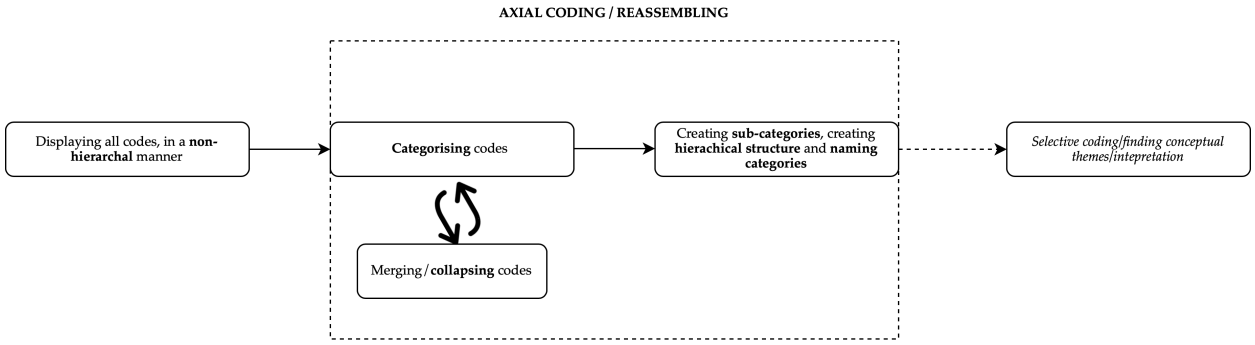


Figure 5.3 A depiction of the reassembling process.

As seen in the figure, the reassembling process involved taking small steps towards a more focused scope of viewing the data. One example of the decisions taken during this process could be the choice to merges some codes. Once the starting categories where created and reassessed, it became clear that the codes 'General Experience during Activity (Negative)' and the corresponding 'General Experience during Activity (Positive)' did not contribute with much meaning. Each had only one tagged statement. Inspecting these two lone statements, I have opted that it is possibly to re-tag them by using both 'General experience for Ideation' and

'General experience for Evaluation', seeing as (1) both statements (Emilie, 37:15; Johan, 31:11) would fit in these codes just fine since they have 'ideation' and 'evaluation' specific references nestled in them. Additionally (2), the merging/collapsing of these codes would render all codes useful meanwhile reducing the complexity of the overall codebook, visually and conceptually.
For further examples of the decisions made along the reassembling process, alongside the considerations preceding them, please see the created notebook in Appendix (10).

The output of the reassembling is seen in Figure (5.4).

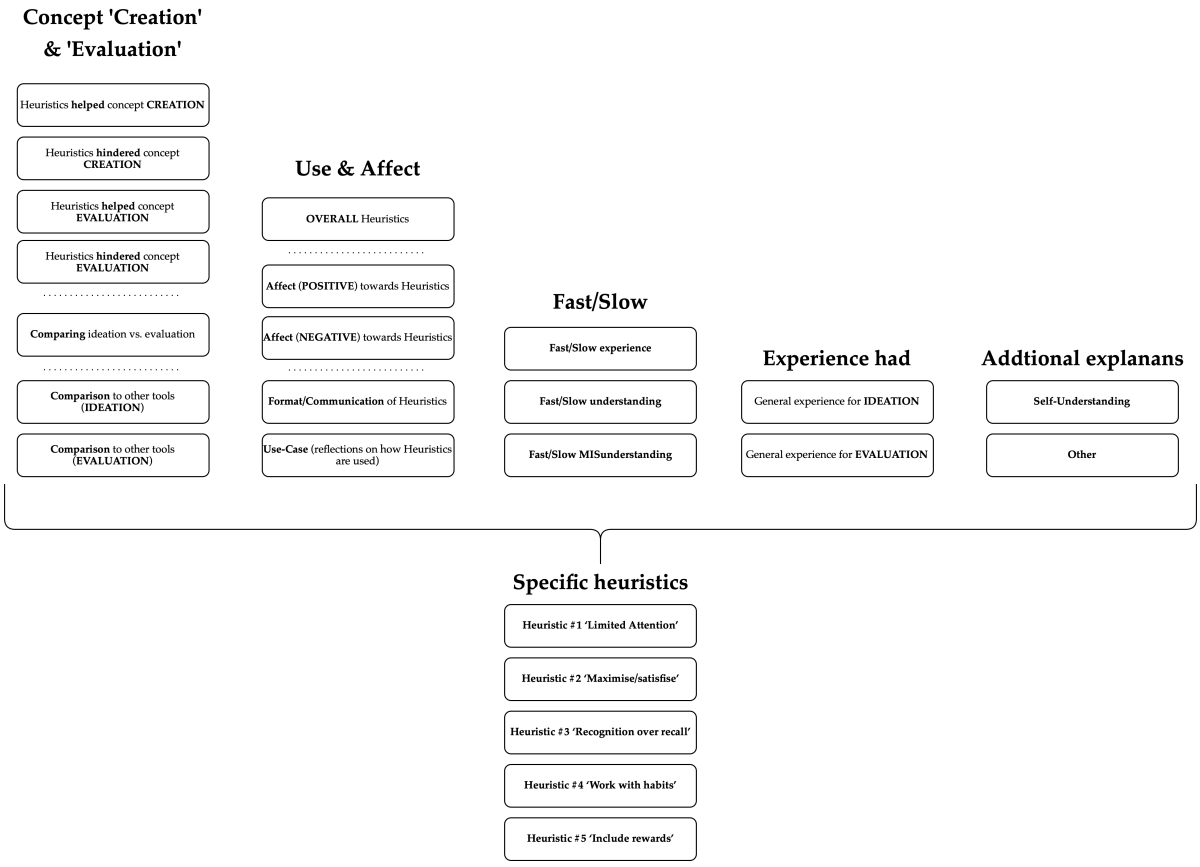


Figure 5.4. A view of the five created categories of codes.

Five categories were created, where the two comprised of the most codes have distinct sub-categories. Common to all categories is that statements tagged with these codes are often tagged with heuristic-specific codes as well. These heuristic-specific codes form a sort of 'meta-category', relevant to the analysis but still with a different meaning compared to the five main categories that have a larger conceptual diversity within them.

The five categories, ***Concept 'Creation' & 'Evaluation'*** (category 1), ***Use & Affect*** (category 2), ***Fast & Slow*** (category 3), ***Experience had*** (category 4) and ***Additional explanans*** (category 5), do not in themselves provide much new insight, as the creation and naming is done in a deductive manner, looking at predetermined codes and creating fitting category names from there. Still, some decisions in the reassembling process help shape the self-created understanding of what to look for in the upcoming interpretation. One such decision was to *not* categorise by predominantly separating the codes into those around 'concept creation' (ideation) and 'concept evaluation' (evaluation). Rather, the codes are categorised with the intent of separating the use of, experience of, and attitude towards the heuristics *in relation to/in the context of* the concept creation and evaluation tasks. Each statement referring specifically to either of the tasks of the Activity will be tagged correspondingly, and therefore that distinction will be made clear regardless of this chosen way of categorising (see Appendix X.X).
Yin (2015) states that the reassembling process through e.g. arrays or tree charts may in some cases not even be crucial before commencing the interpretation phase of the analysis (p. 196). Still as stated, the created categories will be used as focus lens to view the textual data through. With this lens at hand it is now time to progress to the actual interpretation phase.

5.4 Analysis, step II - Interpretation, through grounded data exploration, and findings patterns

The interpretation stage begins first with taking the practical measure of incorporating the newly created five categories into Taguette workspace. This means creating five new codes that enact as parent codes to represent the categories, and then appropriately allocating the lower level individual codes under each category. This makes it possible for me to see all tagged statements of e.g. '*Fast and Slow*', i.e. category 3, or alternatively just the statements of an individual code.

5.4.1 A 'grounded' data exploration

The first chosen step in the interpretation is to revisit the textual data through each of the five categories, one at a time. I have chosen to perform this first step with a somewhat *grounded* approach, trying to put aside the interview guide and research questions. This is to give myself a higher probability of engaging with the data in a curious manner, allowing myself to become intrigued, perhaps even surprised, about what has been said by the participants in this Main Study. I say 'somewhat'

grounded approach as the entire deductive approach thus far renders it impossible to approach the data in a truly grounded manner.
Moreover, the 'grounded' approach allows me to look at the statements within each category and be open to a possible iteration of the axial coding (i.e. a re-categorisation of the codes), which would then alter the grounds for my interpretation stage. Williams and Moser (2019) advocate for this dynamic and nonlinear approach, where the researcher, "*..interacts, is constantly comparing data and applying data reduction, and consolidation techniques… …This cyclical process is both an art and science, requiring the researcher to understand intimately the data by continuously reading and rereading the collected data in order for theory to evolve.*" (Williams & Moser, 2019, p. 47). And, although the purpose is not directly to *evolve* theory but rather to *test* it, this approach still helps in emphasising the validity of the analysis throughout its steps by being a 'responsive investigator' continuously in tune with the data and needs of research, as Morse et al. (2002) would put it (pp. 17-18).
The notes taken during this grounded exploration can be found in Appendix (10).

From this somewhat grounded exploration notes were taken for almost every coded statement, meaning only a slight reduction in the *quantity* of data represented in these notes. However, with the note-taking I tried to be interpretative in an open manner, rephrasing only the sentiment of each given statement, alongside drawing comparison between participants. This was a way of data reduction in the sense that statements were boiled down to their essentials, for me to better start identifying patterns across the data later on. While the notes taken are deemed as faithfully representing the data from each category, the raw data will still be revisited going forward as a way of rechecking the validity of my interpretations.

5.4.2 Finding themes and patterns in the data

With a more comprehensive understanding of the data, gotten through the prior grounded exploration of the built categories, it is now time to see what is actually meant by the participants within each subtopic of interest. Put differently, for each category the data within will be inspected to draw interpretations. For example, the category concerning design heuristics in relation to concept 'creation' and 'evaluation', i.e. Category 1, will be inspected in order to answer questions such as *do the heuristic better support ideation or evaluation?*

I have chosen to go through the five categories created in a sequential manner (from Category 1 to 5), since this also seems like a logical manner. This will mean starting first with (Category 1) the heuristics in relation to the two tasks of the Activity, and

(Category 2) then nuance those findings with the more personal statements on use and affect. Thereafter, (Category 3) the underlying framing 'Fast & Slow' heuristic might be better interpreted knowing the data from the interpretations of the two prior categories, and those findings might be further checked for potential influencing variables through the (Category 4) experiences had and (Category 5) additional explanans.
Note, this is not a statement to suggest that the data will be interpreted linearly via the categories that I have made and placed in an arbitrary order. There will still be going back and forth between categories for better supplementing interpretations with additional data, or contrasting different ends of the data set, but this approach is deemed a sensical starting point.

As a reader, please note that the interpretation builds up from the categories, as stated. Category 1 will therefore be more lengthy in its interpretation than Category 2, which utilises the already existing interpretation of Category 1. Category 3, 4, and 5 will subsequently get shorter and shorter, adding to the existing bulk of interpretation. I also aim to make the participants known as persons during the interpretation, being that certain statements from an individual may explain or nuance their overall experiences, in a way that would get lost if the interpretation simply focused on the overall picture across participants, disregarding personal differences and traits.

Category 1 - Concept 'Creation' & 'Evaluation'
Throughout the interview guide I placed an emphasis on separating the inquiry of perceptions and experiences of using the heuristics in the concept 'creation' and the concept 'evaluation' tasks, respectively. Participants were asked whether their experience differed in these two tasks of the Activity, and any distinction between the two was followed up by a series of probing questions.
This distinction was to provide an empirical basis for investigating whether the theoretical presumption that user-cognition heuristics, such as mine, would provide the most inherent value during the 'evaluation' part, similar to other usability-oriented heuristics. For a revisit of these theoretically established assumptions, please see Section (X.X).

Going through the data while trying to leave behind any presumption of how and when the heuristics would provide value, if even any value at all, it has become clear that participants (a) *did* find the guidelines valuable for the 'evaluation' task, and (b) they *did* find the guidelines *generally more* useful for the 'evaluation' than for the 'creation' task. A vague indication of this is found in the quantitative overview of how the tagged statements aggregated across codes, in Table (X.X). Here eight

statements were tagged using the 'Heuristic(s) hindered concept creation' code, whereas only two statements were tagged using the 'Heuristic(s) hindered concept evaluation' code.

Concept 'creation', i.e. ideation

I want to begin painting a picture of the concept 'creation', or ideation, task that marked the start of the Activity for the participants. A general impression during the conduction of the interviews was that the participants felt very comfortable with the thought of ideating. In other words, they generally seemed positive about commencing the task. This was a welcomed sight, being that the task of ideating by oneself, while thinking aloud to me as researcher on the other end of the conference room, is quite daunting. As stated in Section (X.X), I tried to consciously create a non-judgmental, and encouraging space for them to engage with the tasks, but nonetheless it was nice that the participants *did* seem comfortable.

This may very well also have to do with the fact that all Kaospilot participants are well-versed in ideation sessions similar to the one of the Activity, i.e. enganging in concept creation for service design concepts, which should be taken into consideration going forward in the interpretation.

While the participants found the act of concept creating easy in and of itself, utilising the heuristics in doing so did not seem to *generally* enhance their ideation efforts. Instead, the experience was quite mixed. However, there were some clear tendencies of *how* the heuristics respectively helped *and* hindered concept creation.

Participant Sofie repeatedly stated that she thought the heuristics helped her in ideating, since she was having an 'off' day, with a heavy head (25:51, 26:40 and 38:49). She elaborates. "*Because when it's hard to ideate as it is, for me right now, it kind of gives me a lens, some different kinds of glasses, I can do this ideation through. Or, it gives me a focus point or place to start.*" (Sofie, 26:40). At the same time it is not hard for her to see the limitation of using the guidelines, should she feel her usual self. They "*… would also slow down a natural flow of ideas, because it would make me go back and forth all the time* [between reading the guidelines and ideating concepts], *and like going out of that creative flow.*" (Sofie, 55:21).

Both of these opposing experiences of the guidelines respectively helping and hindering ideation flow seem to be present amongst the other participants.

Participant Marcus also found that guidelines help coming up with ideas, since "*… it was nice to have some sort of framework to build from. Because the five steps they were really clear indicators of how you can actually develop a concept or develop a product based on that… …I was depending, I was using the five guidelines a lot, going back and forth between the five guidelines, and the ideation.*" (Marcus, 41:03). This was evident during

the Activity by his seamless application of the guidelines, ideating concepts (20:53, 22:51, 26:45 and 28:46). Even though Marcus was overwhelmingly positive throughout about using the guidelines for ideation, in terms of the applicability and value (54:32) and also ease of use (26:45), probing him for nuances later led to him to confidently say "*If they* [i.e. the guidelines] *were to function in 'ideation' the format should be different."* (Marcus, 1:05:19).
The rest of the participants echo what has already been laid out quite well. Participant Bo also stated he had to jump back and forth between the guidelines and the concept creation task, "*because then I couldn't quite remember what it* [i.e. the guidelines] *was about, and so on. So it's also about, like getting it really into the system*" (Bo, 45:47). Still he felt a sense of congruence applying the guidelines, since they function as inspiration that he can use whenever he feel or does not feel like it (45:47 and 51:44), stating "…*in the ideation, I could use the guidelines and I did use the guidelines. But if I came to have an idea it was okay if it didn't fit within the guidelines anymore. "* (Bo, 1:03:19).

Participant Emilie found, like Marcus, Sofie and Bo, that the guidelines enacted as a "*framework"* (Emilie, 38:32) for her to ideate from. On the one hand this was something Emma desired. "*I just started thinking and I don't really have a system of my thoughts. And then I get cluttered.*" (37:15). "*But having a framework of 'this is what you're going to ideate on now'. I mean, it could also be if you implement the guidelines and ideate from one guideline at the time. Definitely for me, constraints are gold.*" (Emilie 38:32). Still, Emilie found the 'constraining' nature of the heuristics more fitting during the following concept evaluation tasks (46:11), which I will return to. But, it indicates that perhaps the value she got from the guidelines during the ideation is somewhat akin to the inspiration that a framework can give, which mirrors the prior statements well.

Participant Julie, the only participant whom should be noted has taken a product design bachelor prior to her Kaospilot education, was overall positive towards the value of the guidelines during concept creation, although her statements also reflect a sense of skepticism. When asking whether she experienced the guidelines hindering her during the concept creation, she stated: "*It made me exclude first and fast ideas from the* [Miro] *board, because some ideas are really bad and not fitting at all to the guidelines. So maybe they curated the ideas a bit. But I think the things on the board are maybe better than if I just put everything on.*" (Julie, 48:46).

Participant Mikkel was the one getting the least value out of guidelines during concept creation. "*I think it was difficult to implement them. When you just read it, like one time or two times, I think the understanding of them was not was not fully, like, in my*

head in order to keep them like fully in mind all of them. So maybe the clarity of the guidelines was still like a little bit… [lacking]*? Like how I could implement it in the brainstorm?*" (Mikkel, 51:44). This lack of understanding through reading and rereading may or may not have to do with Mikkel being dyslexic, and therefore requiring information to appear visually through drawings or videos (1:09:34).

In summary, participants found applying the heuristics for concept creation to be *both* hindering and helping to them. Hindering, in the sense that actively using them can mean a lot of switching back and forth, which disturbs the flow. Additionally it can feel limiting to an otherwise ideation process free of judgment and requirements. Helping, in the sense that sometimes that a completely free ideation process can seem daunting for those seeking some type of framework. To this the guidelines enact as a helping hand of inspiration, or set of constraints.

Concept 'evaluation', i.e. evaluation

With the Miro board full of virtual post-it notes, the participants were now tasked with evaluate their concepts, based on presumed ease of use and user experience. For this task, the participants seemed to *universally* experience a sense of help from applying the heuristics.

Before commencing the interpretation of the data, it is worth noting that the participants did not seem *as* well-versed in the act of concept 'evaluation' as they did in 'creation'. This is an impression in line with the emphasis on the more diverging side of creativity, seen in their education curriculum (Kaospilot, 2021). This may be taken into consideration going forward in the interpretation, same as the impression of the participants ideation capabilities were in the previous subsection.

The prevailing common experience amongst participants is that the heuristics enact as a 'checklist' for evaluating. This helped with knowing what to focus on during the evaluation, making it more simple to carry though.

Participant Emilie states that "*…for the evaluation, it felt more good using the guidelines as it gave more of a checklist in some way.*" (Emilie, 45:49). Participant Marcus similarly stated: "*I will say that for the evaluation, it felt a bit more natural to use the five guidelines as that if you have created the product, you have developed it, and then you read through it* [i.e. the guidelines]*, and then use that as a checklist to see.*" (Marcus, 42:18).

Participant Julie used the guidelines as a way of checking in with herself about whether her favourite ideas really were the 'best' ideas, in terms of being user-centered (50:43 and 51:22). Similarly, participant Marcus says: "*So instead of staying in my own own habits, actually, in my own patterns of thinking, and the ways ways I'm*

critical, and how I think that things should be different, I could be introduced to something new [i.e. the guidelines] *that will bring in new aspects to what I normally naturally just tend to bring into an evaluation, you know?*" (45:24). Participant Johan reflects in a similar way: "*No, I would say that the guidelines are important for both* [evaluation as much as ideation]. *It absolutely makes sense to, before you're done designing something, have guidelines to follow, but then it's also important to check back and evaluate yourself on how well you did using those guidelines*." (Johan 36:16).

Besides participants *experiencing* the guidelines helping, quite a few examples during the Activity provide indication to me as a researcher that this is the case as well (e.g. Julie, 35:35 and 30:39; Marcus, 33:37; Mikkel, 44:46; Sofie, 35:05; Johan 17:00, 18:03 and 21:15; Emilie 26:56, 28:13; Bo, 35:41, 38:19, 42:00 and 43:19). Typically the useful application manifests itself in the given participant (*1*) reading through the guidelines or alternatively jumping straight to a particular one, (*2*) then takes a look at a given concept and thinks about it in relation to the guideline(s), (*3*) and comes to a conclusion about how that concept is either in line with, or opposing, the advice given in the guideline. This results in (*4*) *either* a (*i*) discarding of the concept due to it being incongruent to the guideline(s), a (*ii*) concept being favourited due to 'checking' the guideline boxes, an (*iii*) adjustment to the concept for it to be more in line with the guideline(s), or (*iv*) possibly just a mental noting that the concept is in need of a revision.

A concrete example of this is participant Mikkel beginning to prefer one concept over the other, when realising that it is congruent with a guideline that he particularly finds important. He says:

"*Okay, let's take this one* [concept]. *It should* [help airport travellers keep distancing through encouraging discounts being rewarded over an app] *help keep distance, I think that goes in line with like, when I actually use the guidelines for that one, or, I kind of like it, it was what sparked in in my mind for about the last one. Giving surprising rewards* [i.e. Heuristic #5]. *That and I had that in mind when I thought about that one… …And personally, I like that one. And I think it would, would help people keep this thing* [in mind] *or be better at it."* (Mikkel, 44:46).

In the example it is also apparent that the heuristics and the way the are used in evaluation is also influenced by the use of them during concept creation. Mikkel used the 'Include Surprising Rewards' to help come up with this particular concept, but he also uses it during evaluation by checking that the concept and heuristic really are congruent. Since they are, and because he feels the the guideline in itself

makes sense that concept is favourited as one he believes in for creating a user-friendly interaction.

The only participant expressing some conflict when using the heuristics for evaluation was Bo. He states: "*Maybe it's because I feel when I when I'm ideating… you know, it's just opening up and there's not really any wrong answers. And these frames help coming up with whatever came to my mind. Whether or not it was dependent… on the guidelines, it kind of grew out of these guidelines. But then when you're evaluating within the guidelines, then it can easily become a bit too forced into the frames. So you force it into frames, instead of it scrolling out from the frames?*" (52:57). When following up with the question: "So let me ask, did you feel that in the ideation phase, you could use the guidelines, but you didn't have to, but then in the evaluation phase, you felt more like you had to use the guidelines. Is that correctly understood? Or was it a different thing?" Bo stated: "*Kinda, yeah. You know, in the ideation, I could use the guidelines and I did use the guidelines. But if I came to have an idea. And it was okay. If it didn't fit within the guidelines anymore.*" (Bo, 54:49).

In summary, the heuristics seemed to provide general applicable value to the participants, when they partook in the concept 'evaluation'. The reason as to why the heuristics were more well-liked, and also seemingly more useful, for the 'evaluation' task over the 'creation' task will be delved further into, in the following section of the interpretation.

The comparison between using the heuristics for the concept 'creation' and 'evaluation'

Some prevailing patterns of how the heuristics provide, or do not provide, applicable value across the two tasks may already be apparent from the above interpretations.

In essence what has already been drawn out from the data is (*1*) the way that the heuristics in concept 'creation' work as either a source of inspiration for those seeking help to avoid fixation, or alternatively as a framework that provides a set of constraints helpful for managing the otherwise very loose ideation process. Conversely, for those not in need of help the heuristics can take away some focus and feeling of flow during ideation. For (*2*) 'evaluation' the heuristics are more broadly experienced as a checklist that provides credible external requirements to evaluate ones' concepts through.

The way the participants have opted to use the heuristics differs for the two tasks. Additionally, some participants also come with notions of how they *ought* to be applied differently, according to the given stage of concept development.

Participant Sofie said: "*I think they can like… I think a good thing would be to read them and have them in mind before an ideation and then going into ideation without looking back at them. Or like, then you have them fresh in mind, kind of, but it's not something that's disturbing the process…*" (Sofie, 55:21). This is of course to avoid the disruption of flow. It also shows that perhaps the heuristics are, to those being self-proficient during ideation, preferred to be used this way rather than feeling obligated to use them sequentially in a checklist fashion.
The heuristics would perhaps lend themselves better for ideation with a different framing of how they are intended to be used. Or, a redesign might be beneficial. These considerations will be explored further down the analysis.

Comparing the guidelines to other designer's tools
During the interviews I asked participants to recall some tools they have used for concept 'creation' and 'evaluation', respectively. This was not with the direct intent of seeing how my heuristics compare to other tools, but rather to make a frame for the participants to further reflect on the heuristics via how using them is compared to what they are used to. From it, some interesting findings came forward.

For one, Johan compares it to the 'Discover' and the 'Define' phases of the Double Diamond. In the Double Diamond, this consists of the first diamond, of diverging and converging phases, which really is more about finding the core of a problem through user research. However, what happens when heuristics used for evaluation, in this case mine, are compared to the second diamond (which consists of 'Develop', i.e. the diverging concept creation phase, and 'Deliver', i.e the converging concept evaluation phase)? Typically this is where prototyping and user testing enacts as the primary tool for evaluating a concept. Participant Sofie states: "*I think they* [the guidelines, and prototyping/user testing] *can supplement each other. Or like, give something good to each other. I also think the guidelines are more of use in the initial design phase. And then maybe I would come back to it during a process. But especially in the beginning of a process, and then I would probably test it several times, depending on what it is you're doing. But I mean, you can test and then come back to the guidelines to see if there's a coherence and if people are actually responding to your product. Like how you want them to from the guidelines. So I mean, you can go back and forth between them*." (Sofie, 1:03:52). This highlights the very interesting topic about how these novice designers can relate to the idea and practice of using usability heuristics contra to more substantial usability testing. The lack of mentioning from other participants is perhaps an indication of user testing being out of scope for them in daily practice, even though they develop interaction and service design concepts. On the other hand, it may just be the case that prototyping and testing did not come to mind for any other participant during the interviews.

Lastly, Mikkel compared the guidelines to another interesting evaluation tool. He makes what he calls a 'motivation X realisation' coordinate system. Here, concepts are put up on the coordinate system according to (a) how realistic they are to be realised in terms of time, effort and money - and (b) how motivated you as designer are to see a particular concept become a reality. When asking how he thinks that is different from the guidelines, he says: "*It's more about what you want and what is possible within your time, and scope.*" (Martin, 1:00:40). Reflecting on what is not included within these axes of evaluation, and what he might include if expanding the system, he says: "*Of course, and I really, that's how do you design for the people. And I think it's valuable to know what certain behaviours or certain things are preferred.*" (Martin, 59:12). It seems as if the heuristics might communicate that another premise for evaluating concepts to Martin is important, different from those that are more in terms of viability and personal likings.

In summary of Category 1, these interpretations of the data within the category, Concept 'Creation' & 'Evaluation', provides a broad foundation for understanding how the heuristics were received and applied by the participants. The focus has been to try and distinguish any differences in experiences across the application for two very different tasks, being concept 'creation' and 'evaluation'.
Now, the analysis will build upon these interpretations, in order to gain a more comprehensive understanding of the heuristics in the eyes and hands of the participants.
Commencing to Category 2, 'Use & Affect', the analysis will now seek to contextualise not just *how* the participants have used the heuristics, but also the underlying feelings towards them. This will perhaps shed light upon any surprised, frustrations or (un)realised potential the participants feel towards these heuristics [REFORMULATE].

Category 2 - 'Use & Affect'

Commencing to Category 2, 'Use & Affect', the analysis will now seek to contextualise not just *how* the participants have used the heuristics, but also the underlying feelings towards them. This will perhaps shed light upon any surprised, frustrations or (un)realised potential the participants feel towards these heuristics.

The perceived authority of the heuristics

The very use of heuristics, or guidelines, is supposed to be defined by a feeling of being both voluntary and flexible. This prevents the heuristics from overriding common sense in a given context for the designer. I wrote the following in the instructions for my guidelines: "*These guidelines are meant to help the designer keep fast*

and slow user thinking in mind, when creating concepts for product designs and services. They are not meant as strict rules to follow, but rather as general sound advise." It has therefore been of interest to see whether they would be used freely or more stringently by the participants.
When asking participant Emilie how she had related to these instructions, she said: "*I think that makes total sense. But at the same time, when, when you're creating a product, it needs to also be for to be valid. I just think it's easy to fall into this kind of trap of kind of seeing them as rules instead. But, I guess it's also* [pertaining most] *for me, because I'm not a designer. So if I'm being told, hey, this is how you create something that's valid, this is how you create a product that people need, then I think 'Okay, well shit, then I have to do that'. Otherwise, people won't buy my product cuz I don't know better.*" (Emilie, 48:06).
The statement by Emilie really emphasises an important topic, which is the way the design heuristics can enact as an authority to those, such as Emilie specifically, who feel rather helpless in design process. This may to a lesser degree be similar to what participant Bo felt, when he felt obligated to use all the guidelines as a checklist during the evaluation task. During evaluation, he felt uncomfortable due to the converging nature of it, so it is possible that the heuristics had a higher authority than during concept creation (Bo, 52:57). He later states: "*So maybe I was a bit stuck in that idea that I had to use them all. Okay. But I think in the same way that the kind of the places where I got a bit stuck* [from using the guidelines sequentially]*, also, it helped me come in a new direction, you know?*" (1:01:20). This may indicate that even though the heuristics can in moments of personal doubt feel authoritarian, or downright coercive, this does not necessarily take away a participant's feeling of them being valuable.

Acknowledging and finding a sense of congruency with the intent of the heuristics

In relation, but not equal to, this topic is the way the participants *feel* about the underlying intent of the heuristics, and the value of that intent. If the heuristics are viewed as either non-credible or unimportant design practitioners may feel free to use or discard them however they see fit, with no strings attached. However, a pattern in the interview data is that the participants mostly find the opposite; that the guidelines are both credible and important in what they set out to achieve. Therefore, no participants discarded the heuristics, or avoided using them all-together. Participant Sofie said: "*But I think as a designer, using these, it takes the focus off the product and puts the focus on… it really reminds people that it should be for the benefit of the end user of the product, not? I think it makes you put aside some of those, like, unnecessary features, for example, in the design, because it's just what actually works. So like, I think I just mean it puts a bigger focus on the people who are gonna use your design. Because I guess sometimes when you're ideate, you can forget maybe what is actually*

realistic and how people are going to interact with your design. And this makes it a bit more focused on being realistic, your design. To make it more functional." (Sofie, 53:54). Marcus echoes the same congruence with the intent of the heuristics: "*It* [the heuristics] *was actually helping me to to get out of my own head in a way to look away from my own needs or my own preferences, and then focus more targeted from something else than than my own, like, frame of reference is.*" (Marcus, 44:40). And stating: "*It's super important to help people to design more specifically on how people are different* [at various points in time during the interaction]" (Marcus: 59:49). Mikkel also echoes the intent, saying ""*It is also important for people to have things like that in mind, when designing for either products or, or designing for someone, if it's either service or product, or, like what* [… whatever] *it is, you have to keep the user in mind. Ind I think it's relevant for that*". (Mikkel, 1:10:02).

It should be note that the praises for the underlying intent of the heuristics can very well be subject to both experiment bias and a pleasing effect, even though measures were taken during the interview to circumnavigate this as much as possible.

The format and visual presentation of the heuristics

Aside from these feelings towards degree of freedom using the heuristics and the affect towards the underlying intent of the heuristics, some participants also had feelings about how they heuristics were presented visually. Both participants Sofie (44:08) and Mikkel (1:09:34) thought the guidelines could take advantage of some to of visual aid. Sofie restates the issue of getting out of flow, when going back and forth between reading the guidelines and ideating. One way of addressing this issue, she said, is to use some type of visual representation of the heuristics themselves (43:07). When asking her if she thinks this would help equally in concept evaluation as it would in concept creation, she said: "*No, because I think in the evaluation, then it's a bit more of, it more okay to have those words and take some more time because it's a slower process. Ideation is like more just throwing out stuff that's in your brain more fast. Yeah, so I guess it's like, in consideration to how fast it goes. In ideation I wanted to grow [the amount of ideas] and be kind of fast. So it's like a natural flow. And for evaluation is it's fine that it takes a bit more time, and you sit and think a bit more.*" (Sofie, 44:08).

This type of visual aid would enact possibly as symbols or icons for each guidelines, which the participants then could recognise faster than having to reread the headline of a heuristic. Being a representation of the heuristics Sofie does not seem to replace the text, but rather compliment it with visuals functioning as memory cues.

Both participant Sofie and Marcus adopted this approach of resorting to merely glancing at the headline during the faster paced concept creation task. Sofie said: "*Yeah. Also, [for ideation] when there's descriptions underneath the principles? Yeah, I*

don't really read them." (Sofie, p. 50:59). Marcus said: "*And, now I feel like I need to go back to see that I'm actually using the guidelines clear enough.* [He goes back and takes a look] *I was okay, so that was really easy to return to. Okay. it performs really nicely to have these* [heuristic headlines] *ones too, just to anchor every point. So I can just like, because this kind of summarises what the what the five guidelines are. They are clear, because they kind of remind me of what I was reading underneath. So I don't have to spend a lot of time reading though the text, I can just read the title of the guideline. And then boom! Straight back to the awareness of that sounds good* [he looks back at his concept]." (Marcus, 26:45).

Participant Mikkel, who is a strictly visual learner, also requested a visual approach, although he would prefer to have the heuristics communicate strictly visually: "*So I think for me, at least to like, understand these on a different level I would have to see it. Yeah. In in either a drawing or a video.*" (Mikkel 1:09:05).
Participant Marcus would also like to see the heuristics in a more visual way he said, but here he referred to the fact that the heuristics were not visually present, while he solved the tasks of the Activity. Because he opted for a full-screen view of the Miro board, the heuristics were more difficult to access. "*It would nice to actually have these five guidelines on the Miro board.*", he said (Marcus, 43:00).

To sum up the interpretations of the data within Category 2, Use and Affect, the heuristics were widely acknowledge for their underlying intent of aiding the participants with designing with usability user needs in mind. Some participants, who felt a sense a of personal doubt due to either being new to the subject of task or due to a feeling of *imposter syndrome*, did perceive the heuristics as an outside authority that *had* to be used stringently, as opposed to using them based on a personal judgment in the moment.
Lastly the heuristics were aided by their headlines, which where deemed fitting. However, for even easier recognition of the knowledge each heuristic portrays, several participants argued in favour of utilising visual aids.

Category 3 - Fast and Slow
The data in the third category revolves around the participants understanding and use of the overarching fast/slow heuristic, i.e. the Dual-Process Theory framing that permeates both the introduction, the instructions and each of the heuristics. Most of this data was found towards the end of the interview, since I deliberately saved specifically inquiring about the fast/slow until *after* having gotten a well-built interview with prior statements to contextualise the answers with. This data is considered the least immediate and the most difficult to interpret. This

interpretation may therefore seem of a slightly different nature than with the prior categories, although it has not been with this explicit intent.

The primary understanding of fast/slow

The participants took various ways for explaining their understanding of the fast/slow heuristic. Some utilised examples from their everyday life, where they recognised either fast or slow thinking in themselves, or in others. Some attributed the two modes of processing to something similar to personality dispositions or traits. Some again used hypothetical examples to showcase that they could utilise the fast/slow thinking and predict the user behaviour.

Participant Emilie equates 'fast' thinking to the unconscious, or mindless, habits that drive much of the interaction with social media, stating: *"This one was thinking fast? And thinking slow? I think everything you do on your phone is mostly Thinking Fast."* (Emilie, 32:16). In relation this she also seemed to have an intuitive understanding of 'slow' as users being more engaged with fewer information (54:46). Ultimately, she is able to connect this understand with the prescriptions in the guidelines. For example, in relation to Heuristic #2 - Maximise/satisfice, she states: "*Fast designs have to accommodate those 'show only key attributes of options with the option to dive into detail'.*" (Emilie: 53.07). Participant Julie also, quite rightly, exemplified fast thinking as 'maximising' and slow thinking as 'satisfising' (Julie, 1:02:35).

Participant Johan equates 'fast' thinking more to immediate emotional responses, and 'slow' thinking to be more analytical and slower (43:21), stating: "*I was trying to relate to times in my life when I thought fast and I think I tend to think kind of, quite from like, a more emotional standpoint, which I believe to be a bit more of like fast thinking, where you can have like a react like an instant reaction or emotional reaction to whatever is happening, and you tend to go with that reaction."* (Johan, 42:24).

In the Johan quote we also see a second theme, being that some participants equate 'fast' and 'slow' as something resembling personality dispositions or *mindsets*, i.e. predominant styles of thinking that users tend to adopt. In essence, here participants see people as being predominantly fast, or predominantly slow. Participant Bo sees himself as a 'slow' thinker, in the sense that he is reflective and cautious when making decisions, saying: "*I often resonates a bit more with the slow thinking, because I like to think it over a couple of times before starting on it. And that kind of means that sometimes I feel that I get left a bit behind because someone is jumping very fast from from the very beginning.*" (Bo, 1:10:30). Participant Marcus, quite rightly, equates fast thinking with being influenced by ones emotions: "*I was like, I was trying to relate to times in my life when I thought fast and I think I tend to think kind of,*

quite from like, a more emotional standpoint, which I believe to be a bit more of like fast thinking, where you can have like a react like an instant reaction or emotional reaction to whatever is happening, and you tend to go with that reaction." (Marcus, 42:24). Participant Johan stated the same about being an 'emotional' thinker, and elaborated on it being non-fixed, being a mindset: "*But it's all about how you choose to train your brain at the end of the day, and you can train yourself to be more analytical and less of a human to have like, less of an immediate response."* (Johan, 43:21). When asking him: "So was it surprising that it is that people are capable of both? "(44:16). He swiftly responded: "*Ah, it's kind of something I already I agreed with. And maybe that's why I liked it* [the description of of fast and slow thinking] *is because I'm like, Yeah, that makes sense to me.*" (Johan, 44:27).

This realisation of fast and slow thinking being universally human seems to be a trend *following* the fact that some participants view fast and slow thinking as being similar to mindsets, where a given person is either more one than the other. Put differently, it seems like the blue introductory description of fast and slow thinking, where I write 'All people are capable of both types of thinking. As a designer it is important to have the user benefit from both types of thinking.', provides a change in how the participants understand fast and slow thinking. Several have read Kahneman's (2011) book, or heard about the terms from elsewhere, but if the heuristics actively guides them away from seeing it as concrete personality types and more towards styles of cognitive processing, then that is a welcome change in understanding. For example, Emilie states: "*I think I have the preset mindset of thinking 'fast' is bad. Thinking 'slow' is good. And I think that comes from spending a lot of time diving into, I guess, yoga and meditation. So I have this preset definition of the two things. I mean, none of them are necessarily bad. But that's just my mindset. That is something* [new] *that I can take from it* [the guidelines]." (Emilie, 57:00).

The experience of fast/slow

The participants also give indications of what is was like as an experience to read the fast and slow descriptions. One pattern in this area of the data is that the attitudes are more cognitive than affective, so to speak. Put differently the participants stated more something along the lines of 'I think the fast/slow information is important', rather than stating 'I just love the fast/slow information!'. Still what can be interpreted from the responses are that the participants seem to have acquired and integrated an understanding of the intended purpose of including the fast/slow information. Rather than merely rephrasing what is written in the blue description box, participants were able to

freely resonate over why information pertaining fast/slow thinking is relevant to them as designers.

Participant Sofie stated: "*I thought it* [fast/slow] *made a lot of sense! Because it's like, every thought process is either fast or slow. Or, it's typically like a mix between them, or you know, just like how the whole brain functions. So it makes a lot of sense that they're included in guidelines for a more psychological approach to work.*" (Sofie, 59:50). Participant Marcus was more expressive in his reflection about it, also stating in more detail why he thought the information was useful: "*I think it's so crucial to have it. Come on! Yeah, because it's about giving clear… It's about helping to develop, like the the image around situations where people would act with fast and slow decision making. Yes, basically I guess the way that helps me study* [the information of the guidelines]*, it is the examples that helps me to see… to envision situations in my head. That helps me to make more sense of it. And for me to learn it more, kind of deepen my learning for it.*" (Marcus, 1:09:53). On the other hand, Marcus did also miss some references for the information, saying: "B*ut it could be nice to have some evidence for these statements. Okay. Some numbers, like 'two out of three humans… etc. etc.'".* (Marcus, 55:25). Participant Johan experienced their value as such: "*I would say it* [the fast/slow] *was helpful* [in communicating the guidelines]. *Because it just makes sense that people are habitual creatures, and that they kind of it's decently easy to predict like customer behaviour, and stuff like that. And that's why those kinds of industries exists. And it also makes it a lot easier to design around if you know that people will. People have like, certain habits, and I think a lot of habits can also be generalised.*" (Johan, 45:49).

The experience of the blue text-box of fast and slow information enacting as an **introduction** to the heuristics seemed to be well-received. Participant Sofie said: "Like it was put really simply, and it's like a good little teaser for like, what these guidelines are about, like how to, yeah, why we use them." (Sofie, 58:52). Participant Johan stated: "*It* [fast/slow] *makes it makes a lot easier to grasp when you just say fast and slow thinking.*" (Johan, 50:29). Participant Mikkel stated that the fast/slow introduction seemed in line with his preexisting knowledge of fast and slow from reading Kahneman, in such a way that he did not think much of it: "*I started reading some of the book like Thinking Fast and Slow. But yeah, so I know a little bit about it. But yeah, I didn't think much of it. Like before I started digging into the guidelines? I thought of it as an introduction to what I was gonna read about. And I think it did* [fulfil my expectation for the guideline]. *I think it kind of like encaptured what I was about to read.*" (Mikkel, 1:09:50).

Overall, it seems like the fast/slow (*i*) made sense in such an intuitive way that I helped make the guidelines easier to understand. Second, (*ii*) it did to some degree

fit to the preexisting conceptions participants had from reading about fast/slow elsewhere. And when it did provide a change to their understanding, seen primarily in the notion of fast/slow being mindsets, then that change was welcomed as being congruent as something they thought made sense. Lastly, (*iii*) for some the fast/slow has gone rather unnoticed, in such as way that they either had explicitly positive or negative reactions about it. Perhaps here the fast/slow metaphor can be seen as the editing in a movie. When the editing is noticed, it is usually because it is out of place. When the editing is done skilfully it goes rather unnoticed but helps convey the story it goes rather unnoticed.

Category 4 - General Experience

The fourth category, 'General Experience' concerns statement from participants that just say something very general about their experience in all of the Activity tasks. The statements are tagged in to gain additional information about whether the experience being particularly positive, negative. It could also be reflections about how the Activity was set up, giving away any potential restrictions for the novice designers to act naturally, or to draw on knowledge from past experiences about how to engage in concept creation and evaluation.

In this category only a handful of statements were tagged. Mainly comments revolved around (*i*) being alone for the ideation part of concept creation, (*ii*) feeling limited about the amount of time at their disposal to conduct the tasks, and (*iii*) feeling 'off' or 'sluggish' personally.

Participant Johan felt a sense of time pressure during ideation, but to a degree where it was perceived negatively (28:53). Participant Emilie on the other felt that the short timeframe was overwhelming (41:32).

Both participants Emilie, Sofie and Johan commented on the experience of ideation alone. They stated, as expected, that is was out of the ordinary for them. However, all of the had found redeeming things about the experience. For Johan, it helped to have me engage in conversation with him. He stated: "Maybe I would say, of course, being able to talk it out is also really nice. For me, it just makes things a little bit more playful. At least for myself. So I felt with the ideation process, I was kind of having fun with it. And the evaluation was more so like, sense-making from the fun I'd had." (Johan, 31:11).
Both Emilie and Sofie found the guidelines to help them overcome the burden of ideating alone. Emilie said: "*It was very difficult to sit alone with it. In the ideation, I*

just started from scratch. and that's not a bad thing. But I think starting from scratch if you have a framework to work within, then it's fine." (Emilie, 40:32). Sofie expressed it this way: "*Yeah. Sorry. My brain is not going very fast today. It's just, ideating alone and online it's not optimal. But it's still something. It's actually quite cool to have these guidelines on as inspiration. Yeah, it gives like a different set of glasses to idea with So that's, that's cool.*" (Sofie 25:51).

Category 5 - Additional explanans

The last category, unimaginatively called 'Additional explanans', consists simply of the remain statements that did not fit into the other categories. Here are random, or analogical statements with no direct relevance to the interview process. However, the statements were tagged despite of this, due to being of potential interest for giving away some context to other statements being given by participants. In particular, these statements were about the participants view of themselves.

For example, participant repeatedly denounced herself as a designer (48:06; 49:00). She states: "I'm not the best at creating products. And, yeah, I think I'm more, I have more of a critical head on. So I would be better at evaluating a product once it's already been designed." (Emilie, 49:00). This statement pertains some information about her disliking towards divergent thinking, but more importantly, I helps shed light her personal (mis)conception of design practitioners being all about ideating concepts, and not about evaluating them - which she takes a keen interest in.

Participant Mikkel mentioned, as previously stated, that he is dyslexic and thus needs information being conveyed visually (1:09:05). This of course affects his starting point for understanding, and possibly liking, the written guidelines as opposed to the other participants.

Participant Julie, the only one having a prior design education having attended industrial design at Kolding design school, she stated her disapproval towards an overuse of the term 'design' at the Kaospilot school. "*Sometimes design is really fluffy word for me… …But if I have my clients in mind, it's really when it's the product or service… …it is easier for me to understand your way of thinking design. So in Kaospilot, I think they misuse the word a lot. When you come from a design world* [e.g. from Kolding design school], *and yeah, you cannot just 'design' and 'design' and 'design' and then you do nothing!*" (Julie, 08:06).

5.4.3 Interim summary, and *selective coding*

For this interpretation of my data, I have tried to go through the created categories from my axial coding and thereby explore themes and patterns relevant to the overall research goals of the thesis project. Still, the interpretation as it currently stands is quite open and less conclusive in its nature. This is a product of *selective coding*, where researchers are concerned with 'the process of integrating and refining categories' (Yin, 2015, p. 187). This selective coding can be followed by so-called *process coding*, helping to describe "a series of evolving sequences of action/interaction that occur over time and space" (Yin, 2015, p. 187).
From my interpretation of the data I would argue that certain patterns in the 'interaction' between the participants and my usability heuristics exist. These patterns of interaction are representative of what the Main Study truly has found. I will therefore attempt to highlight these overall patterns and themes via process coding. The resulting output of doing so is a synthesis of Section 5.4.2. For displaying my final process codes, i.e. the overarching themes of the data, I have opted to put them in as keywords to the former Figure of the created five categories, created by axial coding. The result can be seen on the page below, in Figure 5.6:

Figure (5.6). The joint output of reassembling and interpretation process, depicted through initial, axial, selective and process coding.

As can be seen from the figure, the heuristics seem to both help and hinder concept **creation**. When they help, it is because the enact as *framework* that *inspires* people and help them avoid cognitive *fixation*. When they hinder, the prevent a sensation of *flow* for ideation. Additionally, the can feel *limiting* in terms of stifling an ideation process otherwise free of judgment.

For concept **evaluation**. Here, they enact as a *checklist*, simply put, to guide the participants as a set of credible, external requirements for evaluating concepts.

The perceived way of using the heuristics was predominantly that they *could* be used, invoking a sense of voluntarily interaction, but for some there was also a sense that they *should* be used, invoking a sense of coercion.
In general, the heuristics were seen as *important* because of their intent to promote usability and knowledge of the user in concept creation and evaluation. In other words, they were acknowledged for their intended purpose, and participants seemed to feel a sense of congruency with this purpose, meaning that it was *self-concordant*.

When using the heuristics, participants found them to suit concept evaluation more, in terms of their formatting and non-graphical layout. If they were to be equally usable for concept creation, they should be more *visual* to help promote efficient recognition of each guideline, to help with the flow of ideation.

The fast and slow thinking metaphor was either seen as being *enticingly sensical*, helping *promote understanding* of the guidelines, or they were *going rather unnoticed*.

This process coding, or the process of overarching themes, helps to put a dot on the analysis in a sensical place. From it, the most important findings emerge from the Main Study. I will now go on to discuss these findings, drawing upon the rest of the project, such as theory from Section 2. Next, I will go to discuss the project at large in an attempt to approach answer to the Problem Formulation of my thesis.

Section 6 - Discussion and Perspective

In this final Section you, the reader, can take a deep breath because this is the rounding off of the thesis project.

Here, I first try to commence the Discussion. This is done in three stages. I (*i*) first pick up upon the analysis of the Main Study and try to discuss it by drawing upon the rest of the project, such as theory from Section 2. Then, I (*ii*) discuss the methodological concerns to help shed light upon the validity and reliability of the theoretical and empirical research efforts. Lastly, I will try to round off by looking at the project at large in an attempt to approach answer to the Problem Formulation of my thesis.

The discussion leads to a conclusion to the overall project.

Lastly, I will try to briefly draw a perspective to possible future directions this research could be taken.

The discussion of the project will consist of three parts. First, as just stated I will try to reflect upon the findings from the analysis of the Main Study, by drawing upon the rest of the project, such as theory from Section 2. I will then discuss methodological concerns to help shed light upon the validity and reliability of the theoretical and empirical research efforts. Lastly, I will go to discuss the project at large in an attempt to approach answer to the Problem Formulation of my thesis. For good measure, I will restate it here: *'In which ways can Dual Process Theory operationalise as a framing heuristic for user cognition amongst novice designers, during concept creation and evaluation?'*

6.1 Discussion, Part I - Holistically reflecting upon the Main Study

The analysis of the Main Study revealed quite a few interesting findings. The way I would like to approach an convergence towards how the guidelines were received, understood and used is two-fold: First, there is the basic information about parts of user cognition, namely 'Executive Functioning, Working Memory and Cognitive Load', 'Attention and Awareness', 'Habits, and Automatic Behaviour', and 'Judgment and Decision-Making'. These part of user cognition may have be expressed in reductionist terms and ways, but this is the underlying information deductible from the heuristics. Second, there is the fast/slow metaphor pervading the heuristics, and being used an introduction to the heuristics and user cognition in general. By making a distinction between the two, I hope to better be able to later approach and answer of the Problem Statement, in terms of how Dual Process Theory operationalise knowledge of user cognition. Put differently, I want to investigate how the latter helps explain the former and make it applicable.

6.1.1 The understanding and use of user cognition knowledge

In the Main Study, the novice designers seemed to generally *understand* the overall user cognition knowledge being conveyed in the five heuristics, or 5 Guidelines. This interpretation was based on (*i*) the very few worded participant misunderstandings of cognition, i.e. statements where a participant directly interprets the knowledge being conveyed in a given heuristics opposite to the intended understanding. Here, it is important to note fundamental difference between (mis)understanding and (mis)application of knowledge. For now, I will focus on the 'understanding' part. As generally prescribed by authors (e.g Norman,

2013; Carbon, 2019; Frøkjær & Hornbæk, 2002), an introductory understanding about users, and the cognitive predispositions and limitations they when interacting with products/services, will help designers in better design practices. Therefore, as I am to evaluate the participants' understanding of user cognition from the Main Study, I will do so in a pragmatic manner. Here, I look for indications that participants have taken a certain piece of information about user cognition from a given heuristic, and then to some varying degree reflected upon that in a way that signifies adequate understanding. And, looking through all the tagged statements, where participants mention *specific* heuristics, i.e. the heuristic-specific category of codes, it certainly seems as if the information is understood to a degree more than satisfactory.
Of course, there are varying levels of understanding, and since I also focused the Main Study around aspects of the *experience* of using the heuristics, the was not enough time to fully probe into the varying levels of understanding of each heuristic for each user.
However, a good indication the participants' understanding could be to see how they take knowledge of user cognition and somehow apply it. If the application does logically or conceptually correspond to piece of information then that could indicate fundamental lack of understanding.
Looking at how the participants used the heuristics to evaluate concepts (e.g. Julie, 35:35 and 30:39; Marcus, 33:37; Mikkel, 44:46; Sofie, 35:05; Johan 17:00, 18:03 and 21:15; Emilie 26:56, 28:13; Bo, 35:41, 38:19, 42:00 and 43:19) it certainly seems as if they have acquired a basic understanding of the user cognition within the heuristics for them to make sensical applications of them.

Next, I want to talk about the very application of the heuristics, and by implication the application of user cognition knowledge. Participants could, hypothetically, correctly understand the user cognition knowledge being conveyed, while subsequently *incorrectly* apply that correctly understood knowledge. However, as Woolrych et al. (2011) argued, "*Although it is clear that methods can be incorrectly applied, this does not automatically lead to poor outcomes.*" (p. 942). As identified in Section 2.4.2 [HYPERLINK], the overarching applicational purpose of these usability heuristics is *not* to enact as an identification tool to find specific usability problems. Other heuristics, especially those more domain- and context-dependent (e.g. Somervell & McCrickard, 2005), will likely be more appropriate for such use. An obvious example are Nielsen' (1994) heuristics, being context-dependent in that they concern specifically graphical user interfaces. However, as Lauesen and Musgrove (2005) states, the heuristics communicating ideas of usability can just as well be used to 'guide the designer during the design process'.

So, *how* should the heuristics specifically guide the novice designers during the design process? What does it entail? Well, looking back at Section 2.4.1 [HYPERLINK], the heuristics can help novice practitioners improve in numerous ways, in relation to both concept *creation* and concept *evaluation* activities such as those in the Activity of the Main Study.

6.1.2 Applicational use, during Concept *evaluation*

For one, novice designers have been found particularly inefficient and an insecure when partaking in concept *evaluation*. Here, novice practitioners' approaches tend to be farfetched for strategic evaluation and they mainly evaluate by focusing on their own preferences, rather than taking into account the needs of the user (Hu et al., 2019). Additionally, novice designers are found to evaluate in a resource-inefficient 'trial and error' manner, where they have to extensively prototype concepts before adopting any evaluation strategies, as opposed to experts who adopts preliminary evaluation strategies (Ahmed et al. 2003).

It then seems, going back to the findings of the Main Study, that the heuristics were indeed able to aid these novice designer participants in overcoming such tendencies. Let me restate the general trend of how participants used the heuristics for evaluation: The given participant (*1*) reading through the guidelines or alternatively jumping straight to a particular one, (*2*) then takes a look at a given concept and thinks about it in relation to the guideline(s), (*3*) and comes to a conclusion about how that concept is either in line with, or opposing, the advice given in the guideline. This results in (*4*) *either* a (*i*) discarding of the concept due to it being incongruent to the guideline(s), a (*ii*) concept being favourited due to 'checking' the guideline boxes, an (*iii*) adjustment to the concept for it to be more in line with the guideline(s), or (*iv*) possibly just a mental noting that the concept is in need of a revision.

From this it seems as if the heuristic have been applied a strategic manner, where participants have taken in the knowledge of user cognition to evaluate concepts for something other than their own personal preferences. The 'strategic' aspect consists of both (*i*) being able to evaluate concepts early on in the process before prototyping, and (*ii*) by using the heuristics as a 'checklist', as the participant predominantly did. Of course, the participants had no chance to partake in prototyping activities, due to the time restrictions of the Activity, but it was nonetheless encouraging to see that designers were merely able to evaluate concepts on a preliminary basis.

As participant Marcus said: *So instead of staying in my own own habits, actually, in my own patterns of thinking, and the ways ways I'm critical, and how I think that things should be different, I could be introduced to something new* [i.e. the guidelines] *that will bring in new aspects to what I normally naturally just tend to bring into an evaluation, you*

know?" (45:24). Participant Mikkel, stated as mentioned that his everyday practices evaluating concepts usually comes from a 'motivation X realisation' framework, emphasising strictly the viability for a project as well as his personal likings for one concept over the other. He stated: "*It's more about what you want and what is possible within your time, and scope.*" (Martin, 1:00:40). But, over the course of the Main Study he attitude towards concept evaluation seems to change, stating "*Of course, and I really, that's how do you design <u>for</u> the people. And I think it's valuable to know what certain behaviours or certain things are preferred.*" (Martin, 59:12).
From this I would argue that the heuristics have succeeded in communicating both user cognition knowledge (seeing as the knowledge was understood to a satisfactory degree) *and* that the user cognition knowledge has helped the novice designers evaluate in a strategic manner.

6.1.3 Applicational use, during Concept *creation*

It is also of interest to see how the knowledge of user cognition was of applicational value to the novice designers during concept *creation*. Here, the heuristics enacted as a source of inspiration, and as a framework, for those stuck in an ideation process, where every single opportunity otherwise exists for engaging in the way the novice designer see fit. The underlying cognitive phenomena explaining this value of the heuristics is *cognitive fixation*. It is well-known that external information and tools brought in during the concept creation activity can help reduce cognitive fixation (Sopher, 2020, p. 304; Tseng et al., 2008, pp. 217-18). Some participants did as discussed find it very helpful to have the heuristics as a 'source of inspiration'.

There were however also participants who did <u>not</u> find them helpful for concept creation. Rather, they found the heuristics to stifle, or disrupt, the *flow* state that they otherwise had during the ideation process. One immediate explanation can be found for this negative effect. During the concept 'creation' activity I redirected the participants on the interactive Miro canvas, where they could brainstorm with digital post-it notes, while I could observe and converse with them. I did however miss the essential and obvious opportunity to have the heuristics plastered onto the Miro canvas. This would provide a standardised way for the all participants to equally being able to access the heuristics throughout the ideation process. Instead some participants made a split-screen between the heuristics on one side and the Miro canvas on the other. This approach might have been just as user friendly to the participants in terms of accessing the heuristics as if I had put them permanently on the Miro canvas. Unfortunately, other participants opted to switch between program windows every time they needed to see the heuristics, only to then switch back again to the Miro board to proceed with brainstorming. This is an

obvious, very physical disruption of the workflow for the concept creation tasks that should be accounted for. But, ideally it should have been avoided all-together.

However, there might also be an alternative, less obvious but equally interesting explanation for disruption of flow, and the lack of helping with cognitive fixation. In the article by Tseng et al. (2008) they found that what essentially helps the designer avoid cognitive fixation is the timely presence of *analogical similarity*. Put briefly, analogical similarity is information about other design projects, or design methods, that the design practitioner can become inspired from. This can for example manifest itself in a designer feeling stuck during an ideation and then goes to search the internet for inspiration from similar projects. However, for the information to really help the designer overcome cognitive fixation, it has to be of analogical similarity. This means that the source of inspiration can neither be too similar, nor too conceptually distant from the present concept creation activity at hand (p. 202). What is more, the authors have found that when designers have already begun in a concept creation task, they have essentially started an *open problem-solving goal*. "*An open goal has been defined as a goal which has been set but one for which the associated task has not been completed.*" (p. 202). The authors of the study found that when designers have begun with an open goal they are significantly less susceptible to taking in knowledge and tools analogical similarity, due to the person being so fixated on the open goal. Most useful of analogical similarity there consists of what the designer already has come across *before* engaging in the present concept creation activity.
This research poses interesting implications for discussing the use of the heuristics during concept creation. Because if I am make use of the research study's findings, then perhaps I should have created my research design in such a way that I had sent my usability heuristics to the novice designer participants *before* the actual interview - perhaps a week before the interview and then again two days prior to the interview. This would perhaps help cement the heuristics into the longterm memory of the participants. Then, when they finally arrive to the Activity of the interview, the heuristics will be already stored information that is then retrieved via recognition during the ideation process. As such the heuristics might be presented in a *timely* manner for better aiding the participants overcome cognitive fixation. Aside from this, the aiding of their recognition could subsequently help reduce the load on their *working memory*, when they engage in the *switching* of attentional resources going from reading the heuristics in a PDF to ideating on the Miro canvas (see e.g. Miyake et al., 2000; Hofmann, Schmeichel, & Baddeley 2012). Additionally, the participants suggestion that creating conceptually representative graphical icons for each guideline will also help with improving the recognition of the heuristics.

With theses discussions of the understanding and application of user cognition knowledge, I want direct my attention as to whether the fast/slow metaphor of DPT actually could operationalise the knowledge of user cognition.

6.1.4 DPT operationalising user cognition knowledge

The question of whether the fast/slow metaphor of DPT could *actually* operationalise knowledge of user cognition is essential to this thesis project. It serves as the Problem Statement and it has guided my theoretical and empirical efforts throughout the project. For this reason, I want to make use of the information available at my disposal to discuss this topic, to the best of my ability.

In discussing this topic, I see several potential ways of inquiring about it. First, I could look at raw data from the Main Study that indicates whether the fast/slow metaphor has directly taken user cognition and make it understandable and applicable in a way different to if it had been left out. Of course, the study is qualitative and not experimental, and therefore I am unable to statistically infer the effects that the fast/slow DPT metaphor has in terms of being increasing participants' usability capabilities, compared to a set of identical heuristics *without* the use of the fast/slow metaphor. Instead, by looking at the qualitative data, I will have to make inferences from cues such as (*a*) the fast/slow metaphor explicitly helping participants understand and/or apply the user cognition knowledge. Lastly, yet another way to discuss this topic, though to a lesser valid degree, could be (*b*) to look at cognitive and affective attitudes the participants have for the heuristics and DPT language in particular. In other words, I can look at how much, or how little, they emotionally like the fast/slow framed heuristics, and how important they think they are in order to infer the likelihood of the heuristics and the knowledge being adopted by the participants for later use. Here, I will be acutely aware of the fragile premise that I attempt to draw conclusions on.

The Fast/slow metaphor explicitly helping participants understand and/or apply user cognition knowledge

Throughout the Main Study the novice designer participants used the heuristics in various ways, as seen in the analysis in Section 5.4. However, it was also my general impression that the participants adopted the fast/slow metaphor frequently, and in various ways. They seemed to do so in a more frequent manner than they necessarily had to, when I for example asked them specifically about them about fast/slow, towards the end of the interviews.

Conducting a quick word search throughout the coded interview transcripts I found 150 instances of 'fast' being mentioned and 134 instances of 'slow' being

mentioned. I use the words myself a couple of times in the interview transcript, but that is nonetheless an encouraging amount of explicit use, roughly averaging to 20 times mentioning 'fast' and 20 times mentioning 'slow' per participant.

More interesting that just the *amount* of times the metaphor was explicitly used was the *way* the metaphor was used. As explored in the analysis, in Section 5.4.2, participants used the fast/slow metaphor to 'define' the heuristics. Put differently, they took the gist from a given heuristic and defined it through how that might be 'fast' or 'slow' thinking. For example, with heuristic #2, '*Make it possible to decide, based on both little and lots of detail*', the participants equated the compensatory and non-compensatory decision strategies with being fast/slow. In fact, it seemed that for all heuristics, even the adaption of Nielsen's (1994) heuristic of recognition vs recall in heuristic #3 where I did *not* explicitly use the fast/slow metaphor, it was found that participants readily adopted the metaphor into their way of reasoning about user cognition.

As stated back in Section 1.1.3, one of the main challenges with trying to have novice practitioners adopt knowledge of user cognition into their practices of designing has been that the cognitive science simply is not *as* easily understandable and 'clear-cut' in terms of their intended applicability for designing (Hurtienne, 2009, p. 15; Carbon, 2019, p. 11). What I think Dual Process Theory seems to have achieved, manifested here as the fast/slow metaphor pervading the developed heuristics, is that it helps provide a "*general* account of the workings of the human mind", as (Gawronski et al, 2014) advocates for (p. 7). By letting the novice designers have a *general* understanding of what 'fast' thinking and 'slow' thinking is, they make use of that generalised understanding to approach the specific topics of cognition conveyed in the specific heuristics.
(Say something about P stating 'ahh, so this is fast thinking, and I want to avoid that, or…)

Of course, there are also ways the fast/slow has the potential for being misinterpreted, or misunderstood to a degree where it does not fully portray the current 'best practice' definition of the meta-theory held in scientific communities. In Section 2.1.2 this 'best practice' definition actually varies quite a bit amongst researchers, in terms of (*a*) the proposed interaction between Type I and II processes (being either conceptualisation captured by the 'parallel systems, 'Default-Interventionist' or 'hybrid two-stage model' views), or (*b*) the proposed type of entity for the two opposing characteristic of cognitive processes (being either a whole unified 'system' of processes, or a more complex interplay of covariates of families of Type I processes, as well with Type II processes).

However, for the development of my heuristics I oped to leave out any information pertaining the relationship between, or proposed entity conceptualisation of, the 'fast' and 'slow' types of user thinking. I merely stated that they exist and are useful for understanding most types of user thinking. By implication, the novice designers did not seem to draw inaccurate conclusions about the nature of the 'fast' and 'slow' entities, or about their relationship. I opted for convening the most simple conceptualisation possible, without reducing them to grand and rigid personality types.
Here, the one exception of the fast/slow metaphor being potentially misunderstood is worth noting. As found in the Main Study analysis participants *did* have a preconception of 'fast' and 'slow' thinking being more related to 'mindsets' or even to personality dispositions. Several of them had read the Kahneman (2011) book and recognised the theory in my heuristics from there. However, it seemed as if the was also a solid trend of the participants who did initially see fast/slow thinking as two mindsets to more move towards the correct understanding of it being types of cognitive processes that all users are capable of having. Therefore, it seems as if the heuristics did not make their understanding of fast/slow itself worse, but instead aligned it closer to a scientifically valid conceptualisation.
The goal of introducing the fast and slow thinking was however *not* explicitly to have a scientifically correct conceptualisation of DPT, but rather for it to help convey various pieces of information of cognitive science, and help tied those understanding together into a '*general* account of the workings of the human mind'. But, if a completely misrepresentative understanding of fast/slow thinking itself was found then that could likely interfere with this intention. It was therefore positive to see that the novice participants did not misunderstand fast/slow thinking itself.

Of course, what is at the centre of interest is whether the fast/slow metaphor helped novice designers use and apply (herein *operationalising*) knowledge about user cognition. For that it seems that the fast/slow metaphor did help the participants, and that they *felt* helped by it. For example, Participant Johan put it simply: "*It* [fast/slow] *makes it makes a lot easier to grasp* [i.e. knowledge of user cognition], *when you just say fast and slow thinking*." (Johan, 50:29). Additionally, the piece of introduction text, where I outlined fast/slow thinking seemed enact as frame for not only understanding the heuristics when going into them, but it also helped convey *why* it is crucial to have user thinking in mind, when designing. Here, participants Sophie said: "*Like it was put really simply, and it's like a good little teaser for like, what these guidelines are about, like how to, yeah, why we use them.*" (Sofie, 58:52). In that sense, it might have helped towards the overall trend found in the Main Study data of the novice designers increasingly understanding,

acknowledging and prescribing to the importance of designing with user in mind, and to design usability in mind.
As such, the overarching conclusion, when going through the Main Study data and discussing it in terms of the preceding theoretical work, seems to be that Dual Process Theory does indeed seem to be able to operationalise knowledge of user cognition for the novice designers during concept creation and evaluation.

Although this is not the only aspect of the thesis project that serves towards answering the Problem Statements, I believe the above has made a significant converging towards doing so.
With the above overall Part I of the discussion, holistically reflecting upon the Main Study drawing to a close, I will now move on to Part II, concerning methodological concerns across the over thesis project.

6.2 Discussion, Part II - methodological concerns in terms of validity and reliability for the theoretical and empirical efforts

This thesis project has encompassed quite a few efforts in building towards answering the Problem Statement. (*1*) A theoretical exploration was done to found a solid basis of knowledge to develop my usability heuristics rom, (*2*) the heuristics were created, (*3*) and they tested for their validity via the Initial Inquiries. Lastly, (*4*) they were tested by putting them in the hands of a group of novice designers, hopefully, representative of the intended target group.
I will not briefly go over methodological concerns of these four overall activities.

6.2.1 Methodological concerns of the theoretical exploration in Section 2

Perhaps the obvious part of the thesis to discuss in terms methodology is the theoretical exploration of key cognitive processes that DPT can communicate, in Section 2.2. I refer specifically to this part of Section 2 because although other efforts were made in terms of theory these were more declarative and less likely to suffer from logical fallacies. However, in Section 2.2 I attempt the arduous task of both (*a*) finding and exploring theory of key cognitive processes (which involves arguing for its relevance in terms of designing for usability), and (*b*) exploring how those key cognitive processes can be explained by DPT. It is here that one is likely to suffer under any potential logical fallacies by drawing inaccurate relationships

between otherwise related 'theory', i.e. the cognitive science research, and meta-theory, i.e the DPT framework.

During the writings of the section, one of the ways I tried to make the connection between user cognition theory and DPT more solid was to first try to understand DPT itself by conceptualising it. It was my intention that by doing so I would not fall prey of thinking DPT is something that it is reality *not*, and avoid using it as theoretical "…*stone soup, where everything goes.*", as Keren (2013) argues (p. 257). If I that was the case, then it would be easy to draw connections between *every* arbitrary area of cognition that I found interesting. This is certainly not what I strived for.
A related effort for avoiding such logical fallacies was to first make an account of why I chose to explore the respective areas of cognitive science research that I did. Here, I stated why the areas of research were deemed relevant for designing with usability in mind, and I also explained their relations to DPT at face value. This gave a good starting point for then moving into the theoretical exploration in Section 2.2., where I tried to draw connections. Lastly, for the section I tried to the best of my abilities to make use of preexisting theory that *already* deals with establishing the relationship between the given area of cognitive science in question, and the DPT meta-theoretical framework. As such, I did not have to resort to fully establish those relationships myself all throughout, which would leave more room for drawing potential falsely derived connections.

Lastly, the theoretical exploration served as the building of a knowledge basis for me to subsequently start creating my set of heuristics. As Hermawati & Lawson (2016) found in their literature review of researchers creating usability heuristics, this seems to be in line with the 'best' practice, when commencing the creation of heuristics.

6.2.2 Methodological concerns of the development of the heuristics

Speaking of the Hermawati & Lawson (2016) article, a stage during the overall development and testing of usability heuristics, where researchers seem to lack transparency in their decision-making is during the actual creation of the heuristics. In other words, the authors found largely no information about how researchers go from a basis of theoretical knowledge to the finished set of discounted heuristics, attempting to portray said knowledge. In yet other words, it seems as if the creative process of creating discounted heuristics largely can be characterised as a 'black box' for most research articles.

Here, accounting for my interchangeably divergent and convergent efforts was indeed difficult. One area in particular that I had trouble conveying was how I got from the end of the convergent phase in my ideation workshop, seen in Section 3.1.3, where I have stated my preference towards certain initial ideas for developing heuristics via dot-voting, onto the final output of Section 3, which was the prototype for of the heuristics. This was because my approach in Activity 2 towards the development of the prototype was less structured than the structure of Activity 1, which was the ideation 'workshop'. Here, I could go the route similar to creating a *notebook* portraying all my thoughts during the development process of the prototype, sort similar to the notebook I made for my 'grounded' exploration of the coded interview data in the Main Study, seen in Appendix (10). Nevertheless, I tried to declare the desired features that I wanted to include, when formulating the heuristics, and detailing why I thought these were relevant in the creation of the prototype.

With this in place, I now turn to the discussion of how I went about testing the validity of the heuristics prototype, in the Initial Inquiries.

6.2.3 Methodological concerns of the validity check during the Initial Inquiry

In Section 4 my first effort was to make a general account of validity during these Initial Inquiries. Here I proceeded to argue that accounts of validity for this thesis project mainly resides within the realms of qualitative research. As such, validity should thought in a different manner than for example conducting a psychological experiment.
I then go to argue that the heuristics must go through a preliminary validity check, since my personal interpretation of whether they accurately distill and portray the preceding cognitive science knowledge is singular and subject to confirmation bias.

Here, I opted to recruit fellow Engineering Psychology classmates for helping conduct the validity check. This decision was made due to them being 'accessible user cognition and usability experts'. This is at least my inference, when taking into account the level of specificity that our education has for precisely these areas that are otherwise less frequently practised, as Nielsen (2005) and Carbon (2019) argues. However, one major methodological concerns is the recruitment of (*i*) only three participants, coming (*ii*) all from the same class of the same education. The notion of them coming from the same education is likely to results in more homogeneous data coming from this first Initial Inquiry. Having gone through the same education at the same time their answers are likely to lack significant intellectual diversity. One approach to redoing this validity check in a way that would remedy this

methodological concern would be to include a more diverse panel of usability and cognitive science experts, perhaps with varying levels of (high) expertise. By recruiting experts that I do not know personally this in turn would also reduce the likelihood of a pleasing effect.
Second, the size of the panel being only three persons is *not* enough to draw conclusions about whether a majority thinks positively or negatively about certain aspects of the heuristics.

Another potential cause for methodological concern is the less stringent way I have approach the validity check, in terms of fully transcribing the process. Instead, I recorded session and heard it through, while noting down just the main points being conveyed instead of transcribing everything. This of course lessens the transparency of what I did *not* choose to code. As Fereday & Muir-Cochrane (2006) argues, even initial coding involves personal interpretation (p. 83). By omitting to transcribe the session I have lessened the transparency of my interpretation. In extension, this Initial Inquiry cannot be inspected for my own confirmation bias, which in this case would be to only write down the statements in favour the heuristics passing the validity check. Of course, this has not been my direct intention. Also, it should be noted that the main purpose of the thesis project is not to prove the scientific validity of DPT-derived cognitive heuristics, but rather to investigate the potential of such DPT-derived cognitive heuristics for providing applicable knowledge to novice designers in tasks representative of their typical practices. For this reason I opted to relocate the most of my resources for ensuring a transparent and valid investigation toward the Main Study, which is the most important in addressing the thesis project intent.

The second Initial Inquiry should be briefly noted. Here, I utilised my indirect collaboration with Design-People to recruit for a focus groups of various practitioners within the company. The purpose here was not so much to conduct a validity check but more so to get expert usability designers and user researchers to comment of the heuristics as proposed discounted tool for (novice) designers to engage with usability. For this research Activity I opted for a bit more methodologically stringent approach, exerting more effort into creating a proper moderator interview guide and to subsequently fully transcribe and code the session.
For this research activity my main methodological concern my ability to moderate the focus group. Due to being under then Covid-19 restrictions I saw myself forced to conduct the focus group interview virtually. This proved much harder than anticipated, in terms of picking up on non-verbal cues from the participants to help moderate the ongoing flow of the conversation between the participants, as is the

intention with a focus group method. Therefore, the data seemed to lack a level of richness that is otherwise obtainable with focus groups. On the one hand this was unfortunate, being that the outcome of the activity was suboptimal, in way similar to what Tuttas (2015) warns against, when conducting virtual focus groups. On the other hand, the Initial Inquiry was also meant as testing grounds for me to figure out whether my intended research design for the Main study, which at the time was similarly centered around the focus group method, would be the most appropriate when finally conducting the Main Study. Therefore, as a results of the suboptimal outcome I began to rethink how to make the most of my time with the recruited novice designer participants. In this case, I made some beneficial changes to my research design, most notably going from a focus group method to individual interview, and also to interactive, concurrent TAVP for better aiding novice participants in the process of working alone on the Activity of concept creation and evaluation tasks.

With this in mind, I now turn to the last area of methodological concern, which concerns the Main Study.

6.2.4 Methodological concerns of the Main Study

The Main Study was designed around the learnings made from the second Initial Inquiry with Design-People. However, this does not exclude the Main Study for methodological concerns.
There are many ways to reflect upon the methodological approach of the research activity, but I have found two concerns to be particularly important to discuss.

First and most simply is a concern about the participants recruited. For the Main Study I opted for recruiting Kaospilot students. The reason for doing so was because I saw an apparent fit between their competency profile plus level of eduction (and by implication level of expertise) and then the intended target group *novice* designers, which have been defined back in Section 1.2. Quickly restating, the novice designer target group is thought to be people with *no* knowledge of usability partaking in, or sometimes even being responsible of, design processes. This intended target group is defined by their lack of usability knowledge, not by practising within a certain domain or subfield of design. However, to accurately have the findings of this thesis project generalise onto a wider population being the intended target group, one could certainly argue that the participants of the Main Study should include more diversity. This could for example be achieved by recruiting novice participants via first sending out a call for participants with a questionnaire on various fora or community channels. I could then define a set of exclusion criteria for excluding any potential participants that does not accurately

represent the intended target group. Second, I could have the questionnaire include questions about various aspects of their personality, working style, occupation, level of expertise, interests and more to have information to better select a diverse set of participants, who jointly would make an appropriate representation of the intended target group.
Alas, time and resources were scarce, and I therefore opted for a slightly less ambitious recruiting process. However, this is *not* to say that I personally find the seven Kaospilot participants ill-suited to represent the intended target group. In fact, taken into consideration that they all come from the same education they actually quite diverse.

The Kaospilot education has a minimum age requirements of 21 years for students to apply. This carries with it the implication that the students applying typically come from very diverse backgrounds, due to being unable to apply first thing after high school as with other higher-level educations. The education is also international, which showed only slightly in my group of participants, with one being international. Furthermore, I had closely inspected the Kaospilot (2021a) webpage for indications of their competency profile and (lack of) experience with usability. I subsequently was granted access to their curriculum for their first year, being that the participants were all first-year students, alongside their reading plans (Kaospilot ,2021b) for every course they had taken so far. This provided ample information for me to not make any false assumptions about their level of expertise with usability or user cognition. Based on the material provided to me, and in retrospect reflecting upon the experience of interviewing them, I would deem the seven participants appropriate for representing *novice* designers, although more diversity in the recruited participants of course is preferable.

In respect to the other major are of methodological concerns of the Main Study, I want to touch upon how the research design could have been different in the ways of addressing the research activity.
Setting a case context for participants to try out and apply the developed heuristics was deemed essential for my overall interview method. I opted to reuse the first of the two created case contexts from the second Initial Inquiry, seeing as I deemed it representative of a case the Kaospilot participants would usually partake in, and therefore it would be less likely that the case context of the Activity would cause them any significant problems, interfering with my results. However, one methodological decision that I have substantiated reason for regretting is the decision to only present the heuristics in just prior to the Activity. This entailed that they were given as long as they needed to read and understand the heuristics, before moving on to the Activity. In a conscious attempt *not* to rush them through

reading something they would otherwise take their time with, I assured them that they could take however long they felt the wanted to read and explore the heuristics. In an attempt to emphasise this reassurance, I opted to say that I would go make myself a tea in the meantime and come back again in 10 minutes time. Once I returned to the computer and the Zoom session, I put in my headset but proceeded to act as if looked at some papers, while the few that had not finished finished up. This way, the participants could approach me when they felt done, instead of me coercively asking when they are done.
The seeming problem with this approach is the deducted from the aforementioned research by Tseng et al. (2008) on analogical similarity. If the research design had included the timely sending of the heuristics to the participants some days and/or weeks *prior* to the interview, then the knowledge of the heuristics received and absorbed before the participants have engaged in an open goal. Of course, the heuristics, or the guidelines, *were* provided to the participants prior to the introduction of the Activity, but it is likely that they already had created an open goal from the introduction to the overall interview agenda given at the very beginning at the process. Subsequently, it is possible that the participants were already highly alert and engaged in something resembling an open goal, when the entered the Zoom call due to a pleasing effect. Had the heuristics been strategically presented prior to the interview, then the results pertaining to their use during concept creation might have been less fractured and more positive than they were.

Other than that there are methodological concerns regarding my role as both the (*i*) developer of the heuristics, (*ii*) the researcher of the use of the heuristics, (*iii*) the sole coder of the interview data, and (*iv*) the sole interpreter of the data. However it has been a continuous effort of mine to address this by adhering to the standards of the *verification strategies* prescribed by Morse et al. (2002) throughout the qualitative research efforts. Subsequently, I have tried to accommodate for my role as the only coder by establishing a codebook by the advise given in the (DeCuir-Gunby, Marshall & McCulloch, 2011) article. This was both increase outward transparency of my coding process, alongside attempting to heighten the consistency within my own coding efforts. Lastly, I have tried to make use of the prescriptions by Yin (2011) about commencing an interpretation and analysis guided by principles of *completeness*, *fairness*, *empirical accuracy*, *value-added*, *credibility* (207). One key attempt of doing so has been to provide ample examples via participants statements in my interpretation and analysis.

6.3 Revisiting and answering the thesis Problem Statement

With all these aspects of the Discussion having now been raised, I now see it fit to revisit the Problem Statement of the thesis project and an attempt to answer it. The Problem statement is as follows:

"In which ways can Dual Process Theory operationalise as a framing heuristic for user cognition amongst novice designers, during concept creation and evaluation?

Based on the path taken throughout the entirety of the thesis project, amounting to the Main Study, I go to argue that Dual Process Theory can indeed enact as a framing heuristics for user cognition amongst novice designers, during concept creation and evaluation. The ways it does so is by (*1*) providing a unified, *general* understanding of user cognition and cognitive science. By applying the *fast* and *slow* thinking metaphor, popularised by Kahneman (2011), Dual Process Theory can provide a reductionist language that enables novice designers to more easily express, or put into words, knowledge of user cognition. It provides a lens to see specific information about user cognition through. The use of the fast/slow metaphor of DPT as a framing heuristics was not found to create any substantial misunderstandings or misapplications of cognitive science knowledge. Instead, as it was expressed in the developed guidelines for this thesis project it helped those with a preexisting misconceived notion of fast/slow thinking to rethink their understanding of towards a conception more accurately reflect best practice theory on the subject. Lastly, the DPT-framed set of heuristics, or guidelines, conveying user cognition knowledge were found to mainly enact as either a framework for concept creation, helping novice designers avoid cognitive fixation during the ideation process. Or, the heuristics could have the opposite effect, disrupting an otherwise existing flow of ideation. For concept evaluation the novice designer participants universally found great value in adopt the heuristics as a 'checklist'. This helped the participants with something typical of novice designers, which is the lacking ability to conduct preliminary evaluations of concepts based on criteria outside of personal preferences.

As a general trend, the participants were found to prescribe to the intended use of the heuristics, being to design with the user and usability in mind, displaying a

sense of self-congruence in using them. All of this leads to believe Dual Process Theory holds great potential in enacting as a framing heuristic for user cognition knowledge amongst novice designers in their typical practices of design.

All this being said, I now feel comfortable concluding the project.

6.4. Conclusion of the thesis project

For this thesis project I attempted to highlight a growing problem of novice designers with no knowledge of usability partaking in, or even being responsible of, design projects. I argue that a viable approach towards addressing this problem is to help make knowledge of cognitive science and user cognition more understandable and applicable to novice designers. Through an exploration of different possible ways of doing so I arrive at the conclusion that discounted usability *heuristics*, i.e. design guidelines, can make a sensible medium for helping novice designers understand and apply knowledge of user cognition, in order to better design with usability in mind. In particular, using a meta-theoretical framework called Dual Process Theory (DPT), which makes an overall distinction between two types of cognitive processes, I see potential in framing the usability heuristics through the '*fast*' and '*slow*' thinking metaphor of DPT. This leads to the Problem Statement of the thesis project, which is as follows: "*In which ways can Dual Process Theory operationalise as a framing heuristic for user cognition amongst novice designers, during concept creation and evaluation?*".

I attempt to approach this Problem Statement by first (*1*) conducting a theoretical exploration of the (*i*) key (*ii*) cognitive process that (*i*) Dual Process Theory (DPT) can help communicate. This was done with (*iv*) a preceding conceptual analysis of DPT as a meta-theoretical framework.
From that (2) I opted to explore design-research pertaining information of *how* to go about designing a set of heuristics for helping novice designers design with usability in mind. These heuristics try to communicate easily understandable and applicable knowledge about user cognition and give general, sound advise based on that knowledge. I subsequently (*3*) went through a *creative process* towards the development of a prototype of the heuristics. I (*4*) tested the prototype of the heuristics with a *validity check*, concerning how they communicate cognitive science research, through DPT, in a scientifically valid manner. Proceeding from there, I (*5*) gained *expert practitioners input* on applying the heuristics through a focus group.

From the insights of this, (*6*) I created my final research design for a *Main Study* with *seven novice designer participants*. They were all individually interviewed for their experience applying the heuristics in an Activity that enacted as a case context. Lastly, I went to (*i*) present, (*ii*) analyse and (*iii*) interpret the (*7*) results and findings. This led to (*8*) a *discussion* on the findings of the (*i*) understanding and (*ii*) application of the heuristics during (*iii*) concept creation and (*iv*) concept evaluation. I also go to (*9*) discuss the (*i*) findings pertaining to whether DPT indeed did enact as framing heuristic for the novice designer in these concept creation and evaluation tasks. Lastly, (*ii*) I touch upon a series of methodological concerns of the various theoretical and empirical efforts through the project.

Dual Process Theory was found found show great promise as a framing heuristic of user cognition by providing (*a*) a unified, *general* understanding of user cognition and cognitive science. By applying the *fast* and *slow* thinking metaphor DPT can provide a reductionist language that enables novice designers to more easily express, or put into words, knowledge of user cognition. It provides a lens to see specific information about user cognition through.
Lastly, the DPT-framed set of heuristics, or guidelines, conveying user cognition knowledge were found to mainly enact as either a (*b*) *framework* for concept '*creation*', helping novice designers avoid cognitive fixation during the ideation process. Or, the heuristics could have the opposite effect, (*c*) disrupting an otherwise existing *flow* of ideation. For concept '*evaluation'* the novice designer participants universally found great value in adopting the heuristics as a 'checklist'. This helped the participants with a difficulty typical of novice designers, which is the lacking ability to conduct preliminary evaluations of concepts, based on criteria outside of personal preferences.

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