How Can Neisser's Perceptual Cycle Model Be Used To Identify Users' Information Needs In Maas?

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SUMMARY

This paper aims to demonstrate how MaaS can be optimised by applying Neisser's Perceptual Cycle Model to the Verbal Protocol collected during user trials of a new MaaS app. The results help identify where users' expectations are not met and information needs remain, thus making completion of the Plan, Book, Pay, Navigate task difficult. By identifying where the MaaS app does not match the users' existing mental model design recommendations can be made to increase usefulness and usability.

KEYWORDS

MaaS, Transport, Usability, PCM

Introduction

Mobility as a Service (MaaS) smartphone applications are being launched in many towns and cities worldwide and are heralded as the ultimate modern mobility solution. These apps aim to increase environmental sustainability, challenging car dependence by providing the ability to plan, book, pay and navigate journeys via public transport, micromobility and active travel options into one convenient app (Sucu 2022). Due to the impactful potential of MaaS new initiatives are being promoted by administrations worldwide (Heikkilä, 2014, Department for Transport, 2019).

In order for MaaS apps to be effective in encouraging the public to use more sustainable travel modes it is necessary that tasks are intuitive (Richardson et al., 2023). This can be facilitated by providing users with all of the information they both need and expect. These needs and expectations are based on schema; mental models formed in long-term memory from previous experiences (Bartlett, 1932). Neisser (1976) places this concept of Schema alongside World (information from the immediate environment) and Action to develop the Perceptual Cycle Model (PCM) in which a person is considered within the environment in order to understand their interactions (Revell et al. 2020).

As part of an interactive design process, user trials were conducted with 20 participants who each completed four simple journeys using a new MaaS app. Iterative app design is a methodology based on a cyclic process of designing, testing, analysing and refining an app. This method is particularly suitable for rapid prototyping and learning from design failures (Viudes-Carbonell et al., , 2021). Based on the analysis of data collected during these trials, design recommendations were generated by the Human Factors team and presented to the app developers in order to be implemented in the following iteration of the app. The aim of these recommendations is to increase usability and promote behaviour change across the widest range of potential users.

Method

Ethical approval was granted by the University of Southampton ethics committee (Ergo reference 79579) to conduct a naturalistic user-trial conducted using a new MaaS app to Plan, Book, Pay and Navigate across the range of available travel modes. Overall, 20 participants each completed four short journeys with prescribed start and end points, and free choice of transit mode. The participants were accompanied, observed and (where necessary) assisted by a researcher at all times. The routes were devised to allow the potential for all transit modes offered in the app to be chosen by the participants. During the journeys the participants were asked to verbalise using the 'Think Aloud' method. Each trial, including training at the start and a debrief at the end lasted up to three hours.

Equipment

Trials were undertaken using the public version of the MaaS app available from the relevant app store for their device (Apple or Android). Due to the naturalistic nature of the study participants were not forced to use a particular version. Most participants had downloaded the app on their own personal mobile phone, however two participants did not want to install the app and therefore used a researcher's phone for their journeys. The journeys were undertaken using a personally owned pedal bicycle, a hired pedal bicycle, a hired electric bicycle and a hired e-scooter and by walking as well as bus and train services. Audio data was recorded using a Dictaphone with an external microphone in order to capture the user's verbal protocol.

Think Aloud Technique

The verbal protocol method known as 'Think Aloud' was employed which has been used extensively in automotive research (Revell et al., 2020) and active travel (McIlroy et al., 202,1 a Debanth et al., 2021). This concurrent method was used and involved participants being fitted with audio recording equipment whilst they give a continuous narrative of everything they are doing (action), what they are sensing (world) and what they are thinking (schema).

Participants

Of the 20 individual participants who completed the trials, 11 were female, eight were male and one was non-binary, they ranged in age from 22 to 72 (Table 1). All participants were smartphone users and were able to use at least three transport modes offered in the app. Time constraints related to the rapid app development cycle meant there was a short period for recruitment and the subsequent trial was limited to two weeks. Due to these factors it was not possible to achieve a matched age and gender split.

Table 1: Participant Demographics

	Age bracket	**Male**	**Female**	**Non-binary**	**Total**
	18-34 years (mean 27.9, SD 4.3)	3	4	1	**8**
	35-54 years (mean 42.3, SD 6.9)	3	3		**6**
	55-72 years (mean 63.2, SD 6.5)	2	4		**6**
Total		**8**	**11**	**1**	**20**

Analysis

Once the trials were completed the audio recordings were transcribed verbatim and divided into short segments. The resulting transcripts were thematically coded to identify areas of commonality and then uploaded into the software tool NVivo for qualitative data analysis. The chosen method for analysis of the transcriptions was the perceptual cycle model. This method is well suited to identifying information needs in interface design (Revell et al., 2020) and is based on the work of Neisser (1976) who presented the view that human thought is closely coupled with a person's interaction in the world, both informing each other in a reciprocal, cyclical relationship (Figure 1). By considering the user, the interface and environment together, the users' interactions 'in context' can be better understood (Plant and Stanton, 2012; 2016). The data was coded into the triads according the Neisser (1976) PCM adapted for the MaaS context (Table 2).

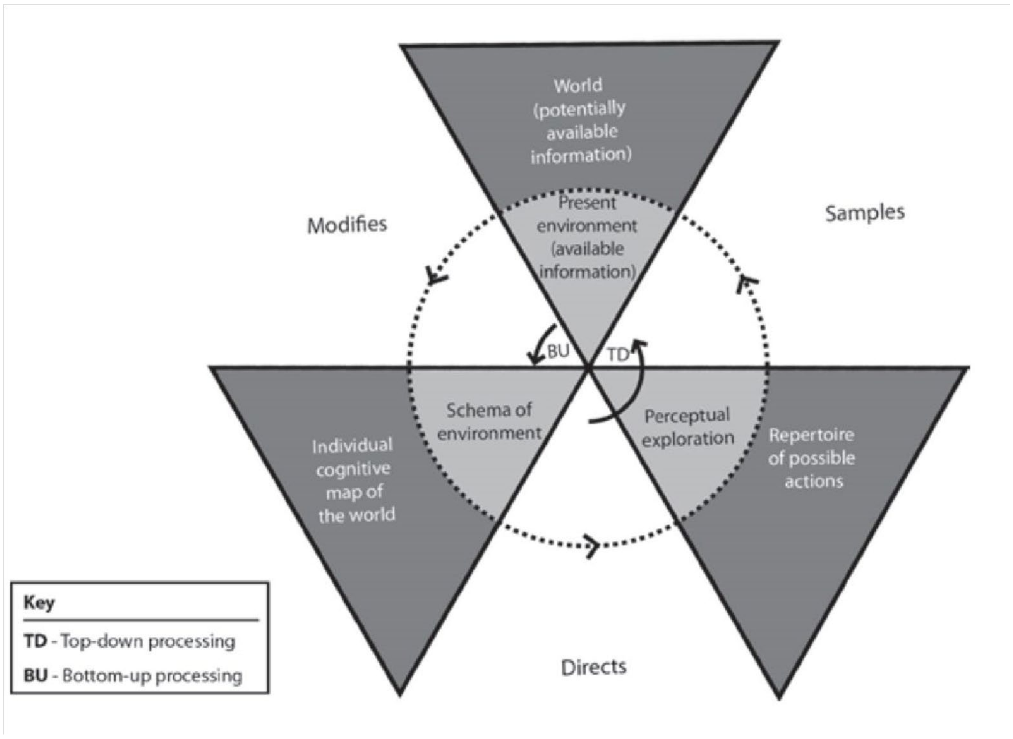

Figure 1. Neisser's Perceptual Cycle Model (Plant & Stanton 2016)

Table 2: World, Action and Schema Adapted for the MaaS Context.

World
References to information observed within the MaaS app. References to information observed within the environment not specific to their journey. References to information observed within the environment specifically related to their journey such as timetables at stops and interchanges or travel information displays on vehicles or at stations.
Action
Actions undertaken by the participant. Actions the participant verbalises they intend to take.

Schema
Where the participants make a reference to their own mental model or expectations. Where the participants make a reference to other travel apps. Interpretation of observed information (this could be a correct or incorrect interpretation) which dictate analysis.

Results and Discussion

The following section is presented as two case studies, examples of where conflicting information coming from the World triad caused the participants confusion, questioning their own Schema and causing Action to be either delayed or impossible without further World information (in the form of assistance). The case studies were selected due to being clear examples of an issue which was experienced by several participants. The VPs collected during the example were broken down and numbered in order of occurrence then categorised by relevance to Schema, Action or World.

Case Study 1 - Difficulty Finding Train Options

This example takes place in the planning stage of Journey 2 by Participant 19. This had the starting location of Southampton Central train station and the destination of Southampton Airport Parkway train station. This journey can be completed using any in-app mode, with the quickest and easiest being a seven minute train journey with trains running every 10-15 minutes. The coded VPs can be seen in Table 3.

Table 3: Coded Verbal Protocol (VP) for Case Study 1

World	**Action**	**Schema**
	1. So, I'm now looking on the app	
	2. putting in where to go, and I'm putting in Southampton Parkway Station	
3. and it says that there is –		
4. so it's just showing me buses, actually		
	5. Trying, again, to put in the details	
		6. I've just got –
7. oh, no – train		
		8. I just didn't really know
		9. I think because the actual – the colours of the blue and the green actually pops out more than the train sign did, actually
		10. Yeah, so I think, visually, I just opted for that
		11. Actually, because it was grey, I just didn't notice it, actually

The participant starts by confidently using the app to plan their journey (VP1-3). In VP4 they state the app is only showing them buses. This information does not match their existing mental model of available transport modes, causing them to internally question the data provided in the app. Their resulting action is unnecessarily trying again (VP5) by typing in the start location and destination into the app in the hope of getting a different result. This time they verbalise their confusion (VP6) before realising they were interpreting the information incorrectly (VP7). They go on to explain (VP8-11) the reason for the confusion which is twofold but connected. The bus information is presented with bright green and blue icons, and this is visually distinctive whilst at the same time the train information is in grey. This was viewed by other participants as 'greyed out' indicating that there were no trains available, an interpretation echoed in design literature (Richardson et al., 2021).

Case Study 2 - Unable to Find Bus Stop

The second example takes place during a navigation phase of Journey 3 by Participant 8. The journey they were tasked with completing was from Southampton Airport Parkway train station to The University of Southampton's main Highfield Campus. The participant has chosen to take a bus, a direct route between the two locations with the bus stop located outside the opposite platform to the one they have just arrived on.

Table 4: Coded Verbal Protocol (VP) for Case Study 2

World	Action	Schema
1. Which bus did we need? We needed U1C		
2. There is only one bus stop,		
		3. so it's got to be coming from here
4. That's the U8 so that's going to the science park		
	5. So walking over to the bus shelter. Walking over to the bus shelter	
6. I can see bus timetables		
		7. Has it got a digital screen?
8. No, it hasn't, it hasn't. It's just got the good old		
9. oh, yes it has. No, it's not. It's not working		
	10. So yeah, just standing under the bus shelter because it's still very hot and trying to find - just double checking. That's going to Eastleigh bus station	

		11. So U1C just maybe - , so maybe… What I'm doing, because I can't - it does say - because I'm such a stickler for everything being - it does say that the U1 goes from here
		12. That's fine
		13. I'm just doubting myself, I guess,
14. because I can't see a timetable for it		
	15. But I'm looking perhaps to see in the app if it tells me that there's another bus stop somewhere, but	
		16. I don't think
	17. Let's look on the map. Let's just recentre the map	
18. Yeah, so we're at the station. There's a bus stop here		
19. This is where the bus is going according to the route		
		20. 18. That's all fine, that's all clear
		21. 19. So yeah, I'm pretty confident that the bus is going to come here and we're going to go from here

This participant is anxious, they are not a regular bus user and are reliant on the app to give them the correct information. The participant has identified which bus they need (VP1) and that there is a bus stop outside (VP2). They decide this must be where they need to go and walk to the stop (VP3, VP5). They seek reassurance from the information on the bus stop (VP6-10) and feel that the information displayed validates their belief that this is the correct bus stop (VP11-13). They check the in-app map again just to be extra sure (VP15-19) and this solidifies their belief "I'm pretty confident that the bus is going to come here and we're going to go from here" (VP21).

Despite their confidence they were not, in fact, at the correct bus stop and the researcher guiding the study was required to intervene, something which was needed by 50% of the participants during this leg of the user trial. Those who did successfully navigate to the bus stop possessed prior knowledge of its location, therefore ignoring the in-app navigation stage of the process. Those participants who could not navigate to the correct bus stop were unable to do so due to a lack of World information available in the app, specifically in the mapping and navigation feature with one participant commenting "I must say this is actually very frustrating because this is why I use Google Maps" suggesting that they have an existing mental model of what World information should be provided in order to complete their journey.

Conclusions

This paper focuses on two case studies highlighting common issues experienced by participants during user trials of a new MaaS app. These issues were confusion of available services based on the use of colour chosen for icons and the difficulty in in-app route guidance to navigate to a bus stop. The importance of the use of colour in icon design and how colour choice can increase their likelihood of being noticed has long been established (Young, 1994) as has the existence a commonly understood visual language (Horton, 1994). Richardson et al. (2021) identified how the use of grey is commonly used to indicate that a particular feature is unavailable or not in use. The experiences of the participants seem to reflect these prior observations from icon design in other domains, thus highlighting the importance of recognising existing schema.

Whilst MaaS apps are relatively new, especially in the UK, many of their features are familiar from standalone apps. Mapping and navigation tools are pre-installed as standard on almost all smartphones, meaning that there is a familiarity with this important feature. Having navigation presented more unconventionally and with less dynamic features, as it is within the MaaS app used during this trial, did not match the user's existing schema. Participants who had prior experience with using travel apps liked the idea that the combined features of Breeze could replace multiple other apps which they currently use but have the expectation that performance should be comparable, if not better than, the ones they currently use before they have the confidence to replace them with a new MaaS.

The confusion of the participants in these examples does not have any dangerous or safety critical ramifications, such as those observed in previous work (Plant & Stanton, 2016, Revell et al., 2020). However both case studies show that confusion did lead to either an avoidable delay or an inability to complete the task of making the prescribed journey solely using information presented in the MaaS app. Using this method of PCM analysis we were able to identify where the participants found completing the Plan, Book, Pay, Navigate tasks more difficult and highlights where their expectations were not met. These expectations are based on what is required to complete the task according to their existing mental models or Schema. By having insufficient World information in the app, it is not possible to complete the intended Action intuitively, leading to dissatisfaction and, in some cases, failure to complete the task without outside assistance. Identifying these outstanding information needs enables design recommendations to be formulated in order to optimise the MaaS app as part of an iterative design process.

The design recommendations which resulted from these case studies are:

- Consider the use of colour carefully, as users will use their existing understanding of how colours are conventionally used when interpreting the meaning of icons.
- Navigation is an important part of MaaS and therefore the functionality of the mapping and navigation features should match those currently provided by competitors in order to meet the expectations of the user.

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