Non-verbal Audio and Tactile Mobile Navigation

A comparative evaluation of two novel prototypes

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***Abstract*—As typical turn by turn systems fail in several aspects to provide an engaging experience to pedestrians in urban environments, we investigate the potential of alternative interaction methods for navigation. We present a two-phase experiment, involving both audio and tactile navigation and discuss the collected evaluation data. Our findings show a positive reception of implicit navigation from our users.**

Keywords—Implicit navigation; audio navigation; tactile navigation; urban environments.

I. Introduction

Typical Turn-by-turn (TbT) GPS navigation applications for pedestrians have proved to be a valuable aid to tourists for navigating unfamiliar urban environments. However, the experience of tourism is not only about following a specific path from point A to point B. More than that, exploring the surroundings of an area, visiting nearby sights and attractions and assimilating sounds and smells are critical factors in the visit experience. Nevertheless, when attention is often shifted away from the surroundings (for reasons such as close following of turn-by-turn instructions or constant consultation of a mobile phone screen), the visitor experience degrades greatly. Krüger et al [1] and Aslan et al. [2] found that typical turn-by-turn systems often fail to help users to form a complete impression of the navigated environment. Pielot & Boll [3] found that users often feel "bossed around" by the explicit commands issued by TbT systems, while Seager [4] also discusses many of the challenges in screen-based pedestrian navigation. It seems that TbT systems are not capable of covering the needs of pedestrians in unfamiliar urban environments and alternative methods for providing instructions to users need to be investigated.

In this paper we describe the design and implementation of a field experiment for the evaluation of two different techniques for pedestrian navigation that we have implemented as prototype applications for the Android platform; one based on the concept of 3D audio scents and another based on a combination of audio and tactile navigation feedback. Our intention was to study both alternatives for suitability in supporting simple navigational tasks in a non-urgent setting, while assigning to the same users the task of using them in order to accomplish similar navigation tasks, extending a previous experiment that investigated the 3D audio case only [5]. Furthermore, our aim was to explore the emotional states raised during the use of these prototypes in order to uncover design guidelines that could inform further development of such alternative guidance systems.

The rest of the paper is organised as follows: First, we provide a review of related work in the field of alternative pedestrian navigation techniques. Second, we describe the two navigation systems that we have implemented and the experiment that was conducted for their evaluation. Then, we present and discuss the results of this evaluation procedure. Finally, we elaborate on the conclusions of our research and provide our thoughts for future work.

II. Related Work

Due to the inability of TbT systems to provide a complete, high quality visiting experience to pedestrians, several works have already investigated alternative navigation options. Since the most detrimental factor in a user's visiting experience is visual distraction, most researchers have attempted to examine solutions using other interaction modes for providing navigation instructions, such as audio and tactile feedback.

Jones et al. [6] and Strachan et al. [7, 8] examined systems based on the idea of auditory display that dynamically adapt the music that a user is listening to, in order to guide them in a certain direction, by controlling the left and right audio channel volume. Route finding applications, such as the AudioGPS system [9], Mediascapes [10], Audio Bubbles [11] and Soundcrumbs [12], have used abstract sounds as an auditory beacon alerting users of their proximity to a location of interest through a brief repeating sound to support navigation tasks and guide users to points of interest. Auditory beacons are generally presented within proximity and activation zones around the landmarks.

Other applications like the Roaring Navigator [13] used stereo panning to indicate the direction of a navigational goal in both a navigational and an exploratory scenario, while estimating the position and orientation of a listener's head by means of a GPS receiver and magnetometer. In [14] Vazquez-Alvarez et al. showed that 3D spatial audio together with Earcons allowed users to explore multiple simultaneous sources and had the added benefit of increasing the level of immersion in the experience. In addition, spatial audio encouraged a more exploratory and playful response to the environment. While these approaches seemed promising, related early work reported that many users are reluctant to use headphones for this type of task [15], citing concerns about being recognised as tourists, or a feeling of isolation from the environment [13]. Additionally, Harma et al. [16] show that 3D audio spatialisation suffers from users' lack of ability to clearly distinguish between front and rear sound placement.

Apart from auditory navigation, many researchers have focused on adopting haptic feedback as a means of communicating navigation instructions to pedestrians. Robinson et al. [17] discussed the concept of navigation by replacing turn-by-turn audio instructions with vibrotactile feedback which is provided through vibration-encoded information when users point their device towards their navigation goal, so as to prompt users to explore, rather than hurry through their surroundings. A similar concept is also discussed in [18], using multiple track points to guide users using a mobile device. Another similar approach to support navigation and orientation in a less obtrusive and distracting way is presented in [19], where different vibration patterns are used to help users reach their target. As the first experiments regarding the efficiency of such a method for pedestrian navigation were encouraging, the researchers proceeded with a large in-situ experiment by releasing the android application PocketNavigator [20] that provides an option for navigation through tactile feedback. According to the data that were collected, this navigation method was adopted in one third of all trips and had positive effects on the user's distraction level. Other works based on the notion of tactile navigation, where the feedback received from the users is positive are presented in [21] and [22]. Moreover, Szymczak et al. [23] performed tests following a combined approach of both audio and tactile navigation instructions focused on tourists, which proved to be useful and satisfactory in a visiting context. Finally, the example of Google Maps Navigation for mobile [24] that introduced vibration in walking mode when the user needs to turn, shows that commercial navigation companies are already considering different navigation feedback approaches, while not yet abandoning turn by turn instructions.

III. NAVIGATION PROTOTYPES AND EXPERIMENT DESIGN

Our intention was to escape the "tyranny" of turn-by-turn navigation by adopting alternative means for providing guidance, such as audio and haptic user interaction. For this reason, we have implemented two prototype navigation systems for the Android platform: SoNav [5], which is based on the notion of 3D audio scents and TactiGuide, which uses a combination of audio and tactile interaction in order to provide guidance instructions. In both cases our purpose was to augment a user's perceptive experience with continuous (rather than discrete) cues for navigating through the environment. We believe that such navigation applications mainly target users that would like to go from A to B, but are not in a hurry and do not want to just take the shortest route (e.g. tourists). Our target user is a person that wants to head towards a destination, and explore along the way until they eventually get to that point.

A. The SoNav prototype

SoNav is an application that uses 3D spatialised audio on a mobile device to deliver feedback about a user's position compared to a predetermined path. The user selects a start and end point from a map-interface on their device. A path between selected points is calculated using the Google directions service and is drawn on the map. Alternatively, a user can load a pre-defined path stored locally on the device. The waypoints of each path are drawn as small orange blobs. Each path is thus divided into appropriate segments, which are later used to determine user distance and azimuth to the path. The user then puts on their headphones, places the phone in their pocket and starts to walk toward their destination and along that path.

The application calculates at every position update the distance of the user from the nearest segment of the path and also the relative azimuth of the user to that of the nearest path segment. According to this calculations, the source orientation of the sound changes in such a way so it would seem to the user that the sound is emanating from the direction of the nearest path segment. As the user changes positions at different angles to the left or right of the path, the sound shifts in 3D around them to indicate the relative position of the path. Additionally, as the user moves away from the path, the sound volume becomes lower to convey a sense of having veered away from the path. As shown in Fig. 1 below, the user has been located and the green arrow shows her position. Her chosen path is outlined in green and the nearest segment to her is shown in red. Depending on the user's orientation, she would hear audio feedback from her left ear if she faces east, right ear if facing west, both ears and to her front if facing north and finally both ears and to her back if facing south. The system has an audio range of 160m from the path segments and the volume of the audio feedback decreases as the user walks away from the path, similarly increasing as the user walks towards it. Once the user has selected a route, the interface is no longer used and navigation depends solely on audio feedback. More details about the system's operation can be found in [5].

B. The TactiGuide prototype

The second application, called TactiGuide, uses vibration and audio in order to guide the user to her final destination. Its principles of operation are shown in Fig. 2 and Fig. 3. The user selects her destination on a map and just holds the mobile device on her hands. The device vibrates when it is turned in such a way that it points towards the direction of the final destination in a straight line. The vibration occurs when the device is pointed within ±45 degrees of the correct azimuth of the destination from where the device is pointing. Additionally, the intensity of the vibration varies with the calculated azimuth and as such is less frequent at a greater angle and almost constant when the angle is at or near zero.

Due to the limitations of the Android API, it is not possible to actually control the intensity with which the vibration motor operates. Rather, we modulate the periods of operation using an "on/off" pattern, in which the duration of the "off" periods increase according to the calculated angle from the target and range from 800 to 50ms, while the "on" period duration remains constant at 30ms.

Moreover, the application produces a "beep" sound that can be used to understand how close to their destination the users are. The closer the user approaches, the more often the sound is played, simulating the procedure followed in the "cold or hot" game. For this we have set a maximum interval between "beeps" at 5000ms for ranges over 5000 meters, while the minimum interval is 50ms at a range of 10 meters or less. This interval changes linearly with distance. Therefore, the user is free to explore the urban area without the need to stay near a specific path and when she wants to reconsider her route, she can spot the correct direction by making a slow 360 degree turn with her mobile device on hand, or perform a sweeping motion while remaining still. After a target destination has been selected, the map view can be turned off, allowing the user to navigate based solely on the tactile and audio cues.

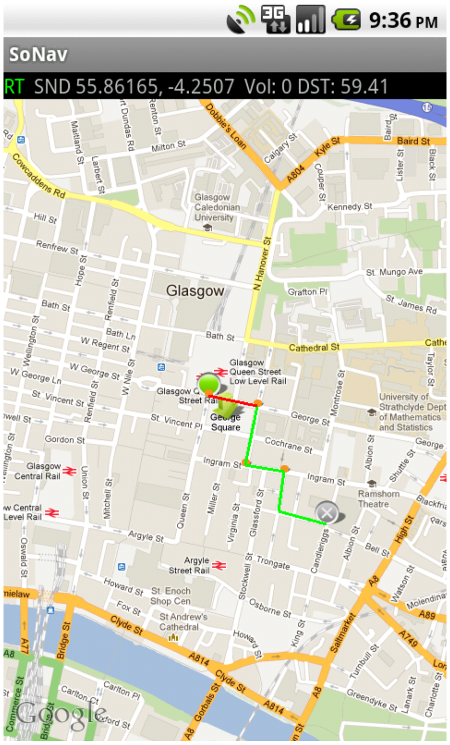

Fig. 1. The SoNav route selection interface.

C. The Experiment

In order to evaluate the two alternative navigation feedback techniques and compare them to traditional Turn-by-Turn systems, we organised and conducted a field trial. We recruited 22 participants, 7 female and 15 male, most of them being university students, while 15 of them aged 18-25, 6 of them 25-30 and one aged 30-35. Seven of the participants reported that they had never used a navigation application in the past. Eight of them said that they had used car navigation applications, three of them pedestrian navigation applications, while four participants had experience with both car and pedestrian navigation.

The experiment took place in a familiar environment for the participants, at the University's campus. We defined two routes (A and B) starting from point A and ending to point B (destination of the navigation task) as shown in Fig. 4. In both cases the distance between points A and B is almost the same (approximately 600 meters) and the two paths are quite similar, requiring no more than 5 minutes to traverse for someone that knows where to go. We kept the target destinations secret from the participants, in order to compensate for their familiarity with the environment. Each participant had to accomplish the task of navigating from A to B using one of the prototypes. All participants used one prototype for one route and the other prototype for the other route. As we did not want the selection of the route to be tested with each prototype to affect the results of the trial, half of the participants walked route A with SoNav and route B with TactiGuide, and half of them used the prototypes in reverse order.

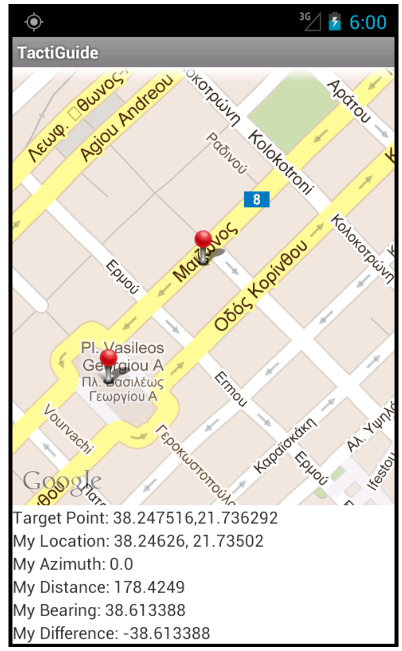

Fig. 2. The TactiGuide route selection interface.

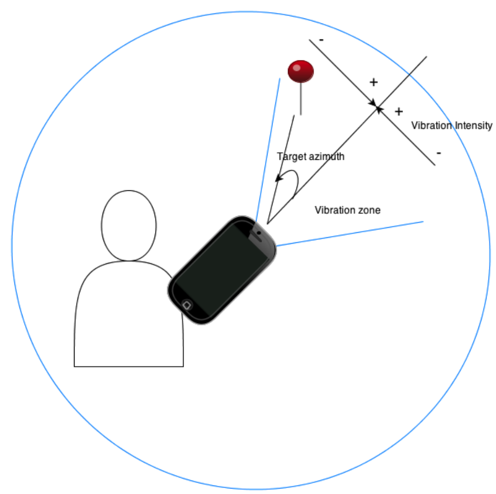

Fig. 3. The TactiGuide operation principles.

Prior to the trial, we briefly explained to each participant how each application works. Then, we configured each application by loading the appropriate route and we gave the mobile phone to the participant. In that way and as the prototypes allow us to hide the map, the participants were not able to see the destination point by looking at the device's screen but had to exclusively figure it out using our applications. We set a time limit of 15 minutes for the completion of each navigation task; however this limit wasn't announced to the participants from the beginning because we did not want to put any time pressure on them during the experiments. At the end of each task we asked the participants to fill out a survey with questions about their experience with the application. The results of this survey are presented in a following section.

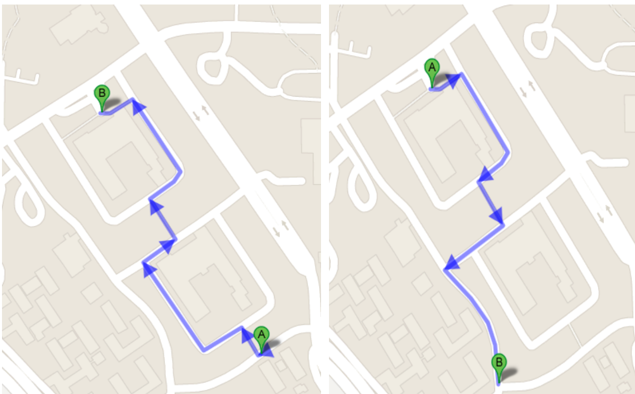

Fig. 4. The two routes followed during the experiment. Route A is on the left, while route B is on the right.

Fig. 5. Two participants navigating using TactiGuide (left) and SoNav (right).

IV. Results

In the following sections, we present an analysis of the recorded quantitative and qualitative data during our experiments.

A. GPS traces

Fig. 6 and Fig. 7 below show the plotted GPS traces from our experiments. As it can be seen, when using SoNav, our participants stopped frequently to evaluate the direction of travel, something that is indicated by the presence of distinct clusters of intensity on the taken routes. In contrast, when using TactiGuide, taking decisions was much quicker and the absence of distinct clusters of intensity shows that users were stopping less frequently in order to orient themselves. In fact, during the experiments, we observed that users would continue to walk towards a constant direction, while moving their arm (and device) about in a sweeping motion, to check whether their orientation should change at the next available opportunity. These observations are supported by the time taken to complete tasks and also the users' average walking speed, as shown in TABLE 1.

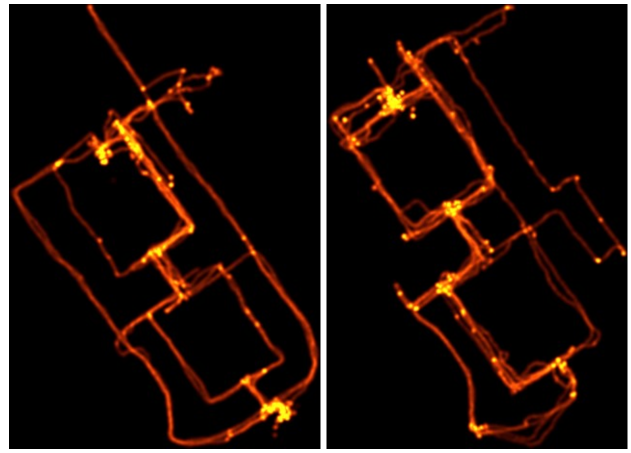

Fig. 6. SoNav traces for routes A (left) and B (right)

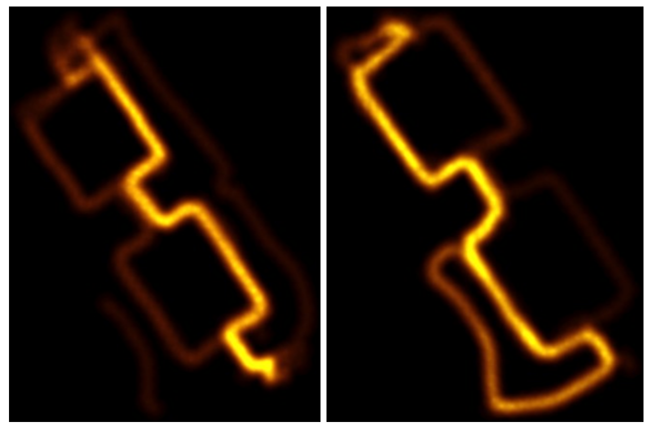

Fig. 7. TactiGuide traces for routes A (left) and B (right)

TABLE 1. Task Completion Times

App	Route	Av. route time (sec)	St. Dev, (sec)
SoNav	A	783.26	142.74
SoNav	B	886.07	134.46
TactiGuide	A	532.64	82.12
TactiGuide	B	561.73	105.59

TABLE 2, Task Walking Speeds

App	Route	Av. Speed (km/h)	St. dev. (km/h)
SoNav	A	1.04	0.14
SoNav	B	0.98	0.16
Tactiguide	A	1.36	0.08
Tactiguide	B	1.32	0.09

It is also observable that participants generally explored a wider variety of route options using SoNav, while using Tactiguide, we can see that most participants followed the same routes. Yang & Schwaringer [25] found that route choice is influenced by the (perceived) direction of the final destination in relation to current position. In our experiment, this knowledge was possible only using Tactiguide and hence, such behaviour could be expected. It is interesting here to note that when presented with an option to turn left or right, Tactiguide users generally tended to turn to the right when presented with a choice. This behaviour is documented in [26], where direction choices at sign-less junctions are shown to be biased to turning to the "right". This influence is attributed to learned driving habits and genetic pre-disposition towards laterality (handedness).

We also analysed the GPS traces from our participants in order to extract their average walking speeds and task duration. All participants completed the task successfully using TactiGuide, while 5 out of the 22 participants failed to complete it using SoNav (2 in route A and 3 in route B). We found that on average, users took less time to complete the tasks and also walked faster using TactiGuide. It is noteworthy that user walking speed is significantly slower than the average human walking speed (approx. 4 km/h), something that could be indicative of a high cognitive load as the users were concerned with the navigation task. These results are shown in TABLE 2, Fig. 8 and Fig. 9. Interestingly, one of our participants (female), disclosed at the end of the experiment that she had almost no hearing ability in her left ear. We were surprised at the statement, particularly because she completed both tasks successfully. In analyzing her logs, the average route time for both SoNav and TactiGuide was very close to the average (906 and 539 seconds for routes B and A respectively).

B. Subjective Evaluations

We issued participants with questionnaires at the end of each navigation task. Each questionnaire collected some basic data about each participant in the first section. Its second section was a paper version of the NASA Task Load Index questionnaire, while a third version asked our participants to express their subjective ratings and emotional states while using the application. A final section allowed participants to input any comments as free text.

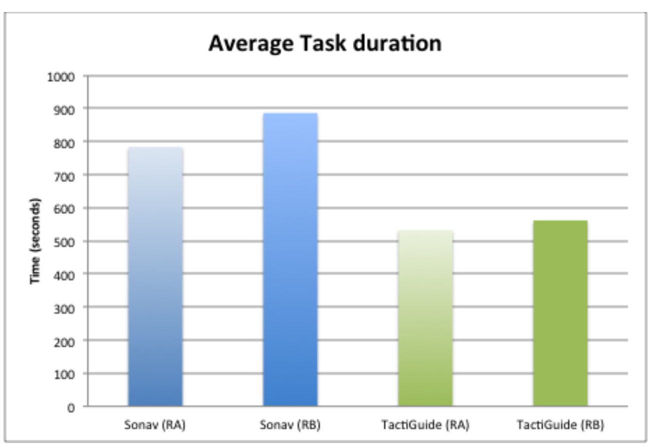

Fig. 8. Average task duration in seconds

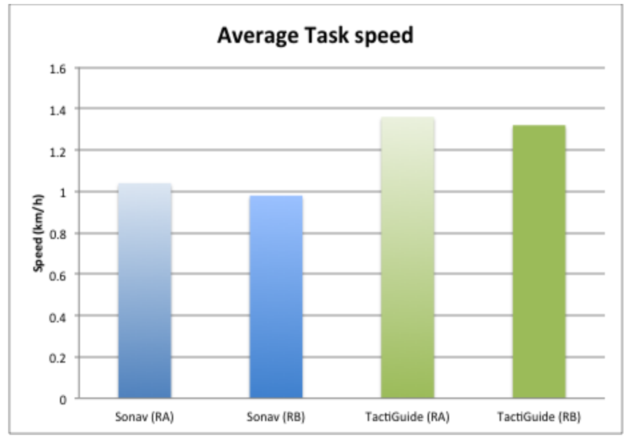

Fig. 9. Average walking speed for each task

1) *Task Load Index results*

Fig. 10 below shows the average scores for each task on the NASA TLX section. From the users' answers we observe that the TactiGuide application achieved better scores compared to SoNav, regardless of the route. Specifically, users reported that they had to put more mental effort ($p<0.01$) in order to use SoNav, though physical effort differences were not statistically significant. Moreover, they felt more frustrated using SoNav ($p<0.01$), which required greater temporal demand ($p<0.05$) and effort ($p<0.01$), resulting in worse perceived performance ($p<0.01$).

In Fig. 11 we present the subjective evaluations of our users. On average, the users liked both applications, giving a slightly better overall score to TactiGuide ($p<0.01$). TactiGuide also was considered to offer more precise guidance ($p<0.01$) while users found it easier to orient themselves to their destination with this application ($p<0.05$). Finally, TactiGuide was found to be marginally better in helping users to re-orientate when they lost their bearings although this was not a statistically significant result.

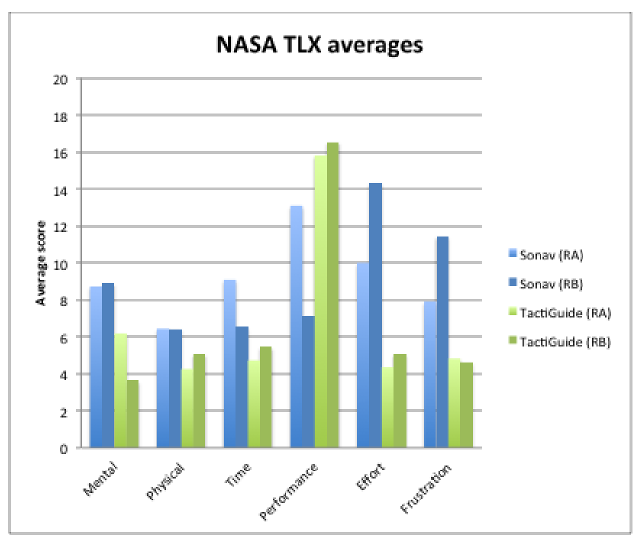

Fig. 10. NASA TLX average scores for each task

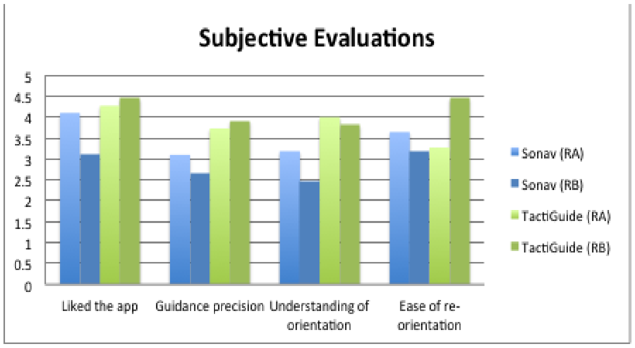

Fig. 11. Subjective ratings for each application

2) *Emotional state analysis*

The questionnaires issued to participants provided twelve emotional states that represented an equal number of positive and negative valence conditions. Our aim was to try to determine which sentiments affect the user experience in navigating with non-verbal instructions and as such to extrapolate design guidelines for such types of applications. The chosen states come from categorizing words relevant to our applications and tasks using the affective ratings in [27], using the delta of each word value from the means. We plotted the states and observed that these are equally split towards negative and positive valence. Arousal in these emotional states is almost equally split based on the classification scores.

In Fig. 12 we present the emotional states of our users during the experiments. Both applications, according to users' feedback, exhibit a common theme: Exploring an area in a relaxed manner, while having fun.

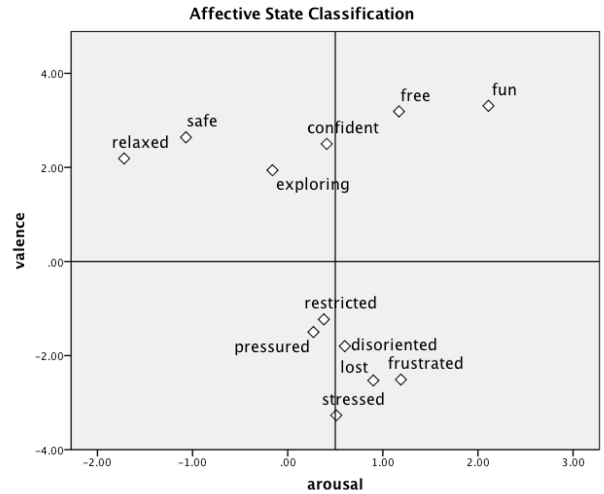

Fig. 12. Valence/arousal affective state classification

Differentiations appear in other sentiments where SoNav seems to rate more highly in negative emotional states, though such feelings are not reported at worryingly high levels.

Comparing the two applications, TactiGuide provides a better overall user experience as the users feel free, safe, relaxed and more certain while exploring the area. Additionally, TactiGuide proves to provide a fun experience for the users. Moreover, with TactiGuide users don't feel any pressure or frustration. Furthermore, users replied that with TactiGuide they never felt disoriented. Finally, comparing the two routes, it seems that route B was a bit more difficult for the users, especially when they used the SoNav application.

Exploring our data further, we attempted to look at potential correlations between the subjective evaluation variables, for

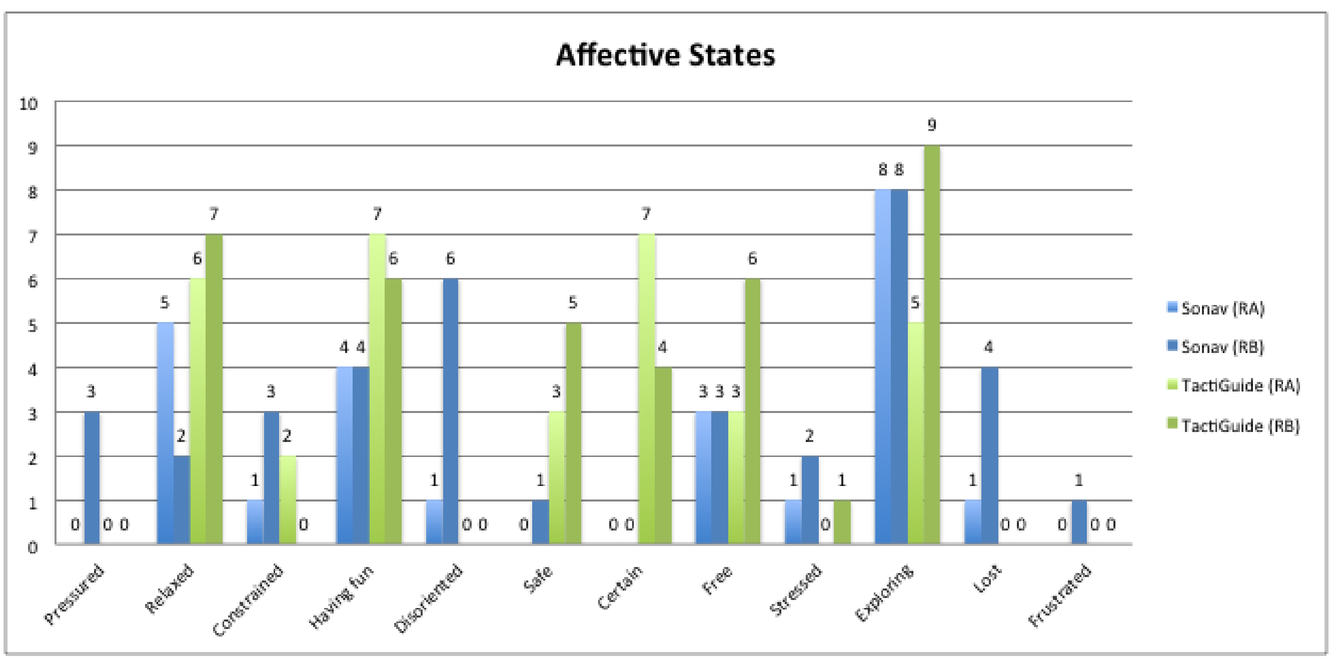

Fig. 13. Reported emotional states for all navigation tasks

each of the two apps. In the following paragraphs, correlation significance levels lower than 0.05 are reported with a single asterisk, while levels lower than 0.01 are reported with a double asterisk.

In terms of actual route time, with SoNav, we found that the time taken to complete a task affected negatively the overall liking of the app *($R_{(22)}$=-0.571**)* and led to feelings that the app was less precise *($R_{(22)}$=-0.512*)*. Route time also raised as it became more difficult for users to re-orient themselves *($R_{(22)}$=-0.527*)*. As route time increased, users felt more pressured *($R_{(22)}$=0.470*)* and lost *($R_{(22)}$=0.436*)* and also seemed to lose the feeling of exploring *($R_{(22)}$=-0.434*)*. Also under the same condition, while they felt that they performed worse *($R_{(22)}$=-0.725**)* and that the task required more effort *($R_{(22)}$=-0.584**)*, we could not find any links to frustration. With TactiGuide, route time seemed to only negatively correlate to perceived performance *($R_{(22)}$=-0.428*)* and we did not observe any other correlations.

In terms of how much users liked the apps, with SoNav it was found that feelings of pressure *($R_{(22)}$=-0.528*)* disorientation *($R_{(22)}$=-0.535*)*, being lost *($R_{(22)}$=-0.477*)*, effort *($R_{(22)}$=-0.583**)* and overall frustration *($R_{(22)}$=-0.566*)* were inversely linked with the overall ratings, while the sentiment of exploration *($R_{(22)}$=0.424*)* and perceived performance *($R_{(22)}$=0.773**)* was positively correlated to it. With TactiGuide we found that users liked the app more when they felt more relaxed *($R_{(22)}$=0.437*)* and having fun *($R_{(22)}$=0.437*)*, and when they perceived their performance to be good *($R_{(22)}$=0.507*)*. On the other hand, feelings of high mental demand *($R_{(22)}$=-0.430*)*, temporal requirements *($R_{(22)}$=-0.495*)*, effort *($R_{(22)}$=-0.513*)* and frustration *($R_{(22)}$=-0.658**)* where negatively linked to overall rating.

On the emotional state axes, we found that using SoNav, perceived mental demand was negatively correlated with the feeling of disorientation *($R_{(22)}$=-0.426*)*. The feeling of exploration seemed to decrease the perceived temporal demand *($R_{(22)}$=-0.510*)*. Performance was impacted by feelings of being pressured *($R_{(22)}$=-0.534*)*, disoriented *($R_{(22)}$=-0.648**)* and lost *($R_{(22)}$=-0.480*)* and rose when users felt more relaxed *($R_{(22)}$=0.455*)*. In terms of effort, it increased with pressure *($R_{(22)}$=0.586**)*, disorientation *($R_{(22)}$=0.632**)* and a feeling of being lost *($R_{(22)}$=0.574**)*, while it decreased when users felt more relaxed *($R_{(22)}$=-0.455*)*. Frustration was less when users reported being relaxed *($R_{(22)}$=-0.548**)* and having fun *($R_{(22)}$=-0.553**)*, while feelings of disorientation and being lost were linked positively to it *($R_{(22)}$=0.625** and $R_{(22)}$=0.455* respectively)*. When using TactiGuide, we found that mental demand was negatively linked to feelings of relaxedness *($R_{(22)}$=-0.479*)* and freedom *($R_{(22)}$=-0.487*)*, while relaxedness and certainty led to a lower temporal demand perception *($R_{(22)}$=-0.602** and $R_{(22)}$=-0.506* respectively)*. These same feelings were negatively linked to perceived effort *($R_{(22)}$=-0.553** and $R_{(22)}$=-0.508* respectively)* and the feeling of exploring seemed to increase with the perceived effort *($R_{(22)}$=0.581**)*. Overall frustration just seemed to be negatively linked to relaxedness *($R_{(22)}$=-0.606**)*. We did not find any correlations for the emotional state of being "stressed" that reinforces our belief that such non-verbal guidance apps can offer a positive experience during use in non-urgent situations. Physical exertion was not found to be correlated to any other variables either, though this could be attributed to the short duration of the assigned tasks and might be worth further investigation during longer trials.

3) User feedback

Our questionnaire allowed for some free-form textual comments by the participants. For SoNav, most users made a comment about the audio feedback. A general trend was that users would like to be able to select from different types of audio feedback, according to how busy the environment that they were in was. Four users felt that directional audio was possibly not enough and that it might be better if semantics were attached to sound:

"I would like a different sound to play depending on which direction the path is."

"It was hard for me to distinguish front and back"

Four users also commented that a hybrid system would be preferable:

"I would like to have got some clues about how to start off first and then continue with the audio"

"How about a hybrid system that also uses turn-by-turn instructions?"

"I would like the system to pause at junctions and give me a musical cue about how to start off again"

"Though I didn't get to the destination, I think this is a great idea, particularly if you could combine it with the other app [TactiGuide]".

Further comments related to the limitations of the prototype, as users would have liked more freedom to place the device at any orientation (e.g. in jacket pockets). One user also mentioned they had fun using SoNav as a playful alternative:

"I think SoNav is not appropriate for guidance in the classical sense. It's fun and interesting and keeps me engaged. It's a perfect game app and helps exercise!"

Comments relating to TactiGuide were mostly related to the function of the tactile and audio feedback from the app. It appeared that users had conflicting opinions on whether they would like vibration to be used for direction indication and audio for proximity, or vice versa. Conflicting opinions were also given on the vibration function:

"Instead of the audio beep, I'd prefer vibration"

"I'd like the system to vibrate only when I'm heading to the wrong direction"

"Allow the users to inverse the vibration so that it only fires when you turn to the wrong direction, so they can save on the battery"

Two users stated they would like to have the system work without holding it, e.g. keeping the device in their pockets. A further two users stated they would like the system to identify milestones and not just point towards the general direction of the destination. Finally, three users suggested adding additional visual cues:

"Please add the estimated remaining time to arrival and distance to target"

"It would be helpful to have an arrow on the screen".

"I'd like to see my coordinates and position on a map"

Interestingly enough, this last comment was the only comment that a user made with reference to a map.

V. DISCUSSION AND CLOSING REMARKS

To our knowledge, our work is the first in trying to assess emotional aspects in non-verbal and non-visual mobile guidance applications. Thus the main contribution of our work is to pave the way for further insights into how application design can be based on the emotional responses that such applications must elicit from users in order to become usable. To some extent, several of our findings were expectable and seem to make sense. We cannot, of course, claim causality for any of these correlations, but two significant findings seem to emerge from this analysis. Firstly, the feeling of exploration seems to play an important role in how much users enjoyed the applications, so much so that in the case of SoNav (our worse performing app in actual route times), it altered their perception of actual temporal demand. This feeling is strongly present in both apps. Secondly, frustration in both cases seems to be strongly linked to how much effort users believed they put into the task and impacts negatively on overall rating. However, frustration levels are below average for both apps, something that is also reflected in the overall ratings and the fact that definite frustration emotional states were only reported in one case, while the reported effort levels are average in the worse case (SoNav). These findings show that non-verbal guidance is a viable alternative for users and yet, still not deployed commercially. In [5], it was found that non-verbal audio navigation feedback imposed some confusion at the beginning of a task for users and this was attributed to the effects of "arrival stress" where the user attempts to orient and familiarize themselves with the new environment and its correspondence to the navigational aids (paper maps or other). It seems thus that a TactiGuide style guidance, which causes less mental demand and requires less effort to use, could be a good candidate "starting mode" to point the users to a certain direction, after which a non-verbal guidance mode like SoNav can effectively support the exploration of a new environment.

Further work opportunities seem to arise firstly in the creation of hybrid systems that combine elements from both types of system presented here. It is encouraging that users did not report desire for map-based visual elements in all but one case, though some additional fallback visual cues might help reinforce user confidence and alleviate some of the negative feelings reported in our experiment. Our work is limited by the fact that we used short routes in a relatively quiet university environment. We report our findings thus with some reservation and hope to be able to repeat our experiments in a variety of urban situations that will more closely reflect different visitation scenarios.

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