# Analyzing Eye-gaze Interaction Modalities in Menu Navigation

R. Grosse[1,2], D. Lenne[2], I. Thouvenin[2] and S. Aubry[1]
[1]*Safran E&D 102 av. de Paris, 91300, Massy, France*
[2]*UMR CNRS Heudiasyc, UTC, Sorbonne Universités, 60200, Compiègne, France*

Keywords: HCI, Interaction Modalities, Eye-tracking, Multimodality, Graphical User Interface.

Abstract: While eye-gaze interaction for disabled people proved to work fine, its usability in general cases is still far from being integrated. In order to design a wearable interface for military products, several modalities using the eye were tested. We proposed a new modality named Relocated DwellTime which aimed at giving more control than existing modalities. We then conceived an experimental military representative observation task where 4 interaction modalities using the eye were tested (2 eye-only and 2 multimodal methods using an external physical button). The experiment evaluated the effect of two types of menus, circular and linear, on eye-gaze interactions performances. Significant results were observed regarding interaction modalities. The modality adding a physical button proved significantly more efficient than eye-only methods in this context and instant opening of menus was rather accepted despite the hypothesis of the literature. No impact of the menu type was observed.

## 1 INTRODUCTION

For decades the study of active interaction with technological systems using the eye as a modality has been undertaken. It started with disabled people and showed that it was possible to use the eye to act on systems. However, for a usual user, the performance of mouse-based interaction tends to be better than with an eye-tracker. However, the analysis of the literature indicates that, if well applied, this method could be more efficient in terms of interactions performances and/or user feeling.

First, there is a natural link between the eye path and the front cognitive task of the user (Liebling and Dumais, 2014). Indeed, the eye is often already staring at where the interaction is taking place.

Second, the eye is the fastest organ of the human body and the execution speed of an interaction is an important component of interaction evaluation.

Third, contrary to other organs that can be fully appropriated by the task, the eye is almost available anytime. For example, the hands of a surgeon are not available to interact with external systems while the eye remains partly available.

On the contrary, some disadvantages have already been exposed regarding eye-gaze interactions. The eye is a sensory organ, but during an eye-based interaction it is used as a motor organ, which is not natural and requests some efforts (Zhai, et al., 1999). This also narrows the time during which the eye may actually perceive. The current inability to differentiate when the eye is used as a sensor from when it is used as a motor organ implies some execution mistakes. This concept was named the *MidasTouch* problem (Jacob, 1993). Furthermore, the eye presents some physiological limits. The unstoppable micro-movements of the eyeball limit the detection precision to about 1°, to which the precision of the tracking-system must be added. These problems lead us to study the conception of specific interactions and interfaces for the usage of the eye as a modality. This may be applied in portable optronics, which appears to be a context in which eye-gaze interaction could be more efficient than classical interaction modalities.

Military infrared binoculars are an example of technologies that integrate more and more functionalities over the years and are used, cognitively speaking, in a very demanding environment. This represents an interesting context to study and propose interaction modality optimizations to allow for decreases in user cognitive charge. Indeed, the observation task does not only consist in watching but also annotating, communicating, using different image processing algorithms to get a target out of camo and so on.



Grosse, R., Lenne, D., Thouvenin, I. and Aubry, S.
Analyzing Eye-gaze Interaction Modalities in Menu Navigation.
DOI: 10.5220/0006538000170025
In *Proceedings of the 13th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2018) - Volume 2: HUCAPP*, pages 17-25
ISBN: 978-989-758-288-2

Because of the complexification of this task, the current binoculars medium of interactions (mainly buttons and joysticks) may limit the usability of future additional functions. As the eye is already greatly solicited in these products, it is a short step to using it as an interaction medium. Several interaction modalities have already been proposed but we aim to evaluate their adequacy to existing interface mechanisms in order to allow cohabitation of several modalities. We also keep in mind to ease the transition between interaction modalities by letting users use interfaces they already know.

The improvement of the eye-gaze interaction should incorporate the conception of a graphical interface adapted to the modality. The choice of an interaction modality that fits the interface and the user task needs to be considered too.

The task that is carried out using the binoculars is the characterization of a point which consists in locating a unit, most of the time on a map, and providing information about it. The information concerns the unit type, size, state or affiliation. The APP-6A (Kourkolis, 1986) standard aims to do this but the number of combinations of characteristics is important. Each characteristic is thus chosen independently, most of the time using multi-level menus. This is a complex task.

Over the years, several interactions modalities using the eye showed up. Some modalities are based on fixations such as the DwellTime method (Jacob, 1993) (Hansen, et al., 2003) (Lutteroth, et al., 2015), Neovisus (Tall, 2008) or on smooth pursuit (Vidal, et al., 2013). Others are gesture-based interactions of which a wide picture is presented by Møllenbach (Møllenbach, et al., 2013). External input mediums are sometimes proposed to specify the user intention of interaction such as a physical button (Kammerer, et al., 2008), a brain-computer interface (Zander, et al., 2010) or even frowning (Surakka, et al., 2004). In practice, the context of use, the task to carry out and the available mediums are limiting the possible modalities.

While using the mouse as the input modality or touch, circular menus such as pie menus have already proven to be faster and to better fit the user task than linear menus in several cases (Callahan, et al., 1988) (Samp and Decker, 2010). For example, the even placement of the items, all at the same distance of the center of the circle optimizes the hovered distance. Moreover, pie menus ease the learning of an expert path. In marking menus, the selection of an item can be seen as a gesture summing the directions of the path during the novice interaction (Kurtenbach, 1993). Some studies seem to assure that circular menus are suited for the gaze interaction. Urbina (Urbina, et al., 2010) compares two eye-gaze interaction modalities: the classic and over-studied DwellTime which consists in starting at an item for a definite time and a new modality named “selection borders” which is the equivalent of marking-menus. It consists in activating an item if the gaze path cut the circle in its direction. However, this second modality was proven harder to use. Kammerer (Kammerer, et al., 2008) compares gaze interactions in pull-down menus versus circular and semi-circular menus and concludes on a better usability of the circular and semi-circular menus.

As we aim to provide interactions which are not linked to a particular type of menu in order to incorporate it in systems with different graphical interfaces, this paper proposes to study four eye-based interaction modalities and whether they preform differently in linear and circular menus.

# 2 METHOD

Our experiment aims to highlight the links between the shapes of menus and the performances or preferences of interaction modalities. The following describes the experimental task and the results.

## 2.1 Participants

This experiment was conducted with 14 participants aged 24 to 43. Five of them had already used the system before for another short experiment that used linear menus but was based on a different task. All of the 14 participants either had a normal vision or a totally compensated vision and all of them were used to frequently using a computer, either at work or during their free time. 9 of them were engineers and all of them had very little knowledge of military tasks.

## 2.2 Interaction Modalities Design

The usability of four interaction modalities is tested in this experiment. These were selected because they match the usability restrictions of binoculars and match the experimental task. Below, we provide a detailed description on how the four modalities were designed. They mainly come from the literature and were partly adapted for this experiment.

*DwellTime* (DT): this is the most studied modality in the literature. It consists in fixating an item with the eye to activate it (Hansen, et al., 2003).

If the fixating time is too short, unwanted activations might appear, and if it is too long the interaction might be boring, therefore the optimal time should be a midway between these constraints. During the fixating time, a visual feedback of the time already spent fixating the item is provided to the user (cf. Figure 2). A semi-transparent picture shaped as the item it highlights appears at the center of the item as soon as the user looks at it. It then linearly grows to reach the item size at the selected dwell time. At this time, the item is activated. The cumulated fixation time on an item is reset only if the user looks away for more than 0.4s. This choice was made for two reasons: the first is that it allows the user to make a “square wave jerk”, which is a fast uncontrolled two-way trip on another location, without having to start the interaction again (Leigh and Zee, 2015). The second reason is to avoid stopping the interaction if the eye is detected outside of an item for a very short time because of the system precision or because of the eye micro-movements. The dwell time is individually set between 300ms and 1000ms during the learning phase of each modality. It is a compromise between the feeling of the user and the expertise of the operator checking that there were neither too many false positives (untimely activations) nor too many anticipations of the activation (when the user leaves the item just before it activates). In practice, dwell times were set with a mean of 625 ± 92ms.

*Relocated DwellTime* (RD): This modality consists in a DwellTime on an always present target located near the item to activate. So instead of directly fixating an item to activate it, the user can decide to activate it by fixating an external linked target whose sole purpose is the interaction (cf. Figure 2). This interaction modality is inspired by the “selection borders” presented by Urbina (Urbina, et al., 2010), which allows the user to activate an item by gazing outside of an item of a circular menu. It is also inspired by Tall’s work (Tall, 2008) which proposes a modality where the user has to gaze at a target outside of the item which dynamically appears when the item is gazed at. This modality allows the user to analyze the menu for as much time as he/she needs without risking any unwanted activation. The cost of this improvement is a more complex gaze path, though we think an expert path is possible where the user may directly look at the targets when he/she knows the architecture of the menu. If this hypothesis proves true, the expert path would not be more complex than with the DwellTime. When a deeper level menu opens, the targets of the main menu disappear. This does not allow the user to close a menu by opening another one anymore. As for the DwellTime modality, the dwell time was set during the learning phase. In practice, dwell times were set with a mean of 477 ± 92ms.


Figure 1: Example of a circular menu using the relocated DwellTime modality. The targets are located outside the circle.

*Multimodal button + gaze* (B): this interaction consists in activating the fixated item with a push on the physical button. This modality allows the user to differentiate intention of action with simple analysis of the interface. However, it needs a good hand-eye coordination which may be unnatural because usually, “the eye precedes the action” (Liebling and Dumais, 2014). In practice, any item is highlighted as it is looked at. Then the user has to press the “space” key on the keyboard provided to actually activate the item. To decrease some eye-hand synchronization problems encountered during pretests, any item can still be selected 0.2s (empirical choice) after the eye started looking away from it if it is not gazing at any other interactive item.

*Instant activation* (I): this modality consists in activating an item as soon as the eye hovers over it. This modality was rejected by the literature (Jacob, 1993) as the *MidasTouch* was introduced. We still think that it may be used in cases where the cost of a mistake is really low (i.e. to open a menu). Instant activation is only used as a way to open a sub-menu from the main one. This is due to the fact that the error of opening an unwanted menu may be easily recovered by looking at another item of the main menu. This modality is thus combined with the Button modality to activate the sub-menu item. A threshold of 20ms was implemented to avoid opening a sub-menu while the eye was going from the main menu item to any of the sub-menu items. No specific visual feedback is associated with this modality except for the opening of the sub-menu.

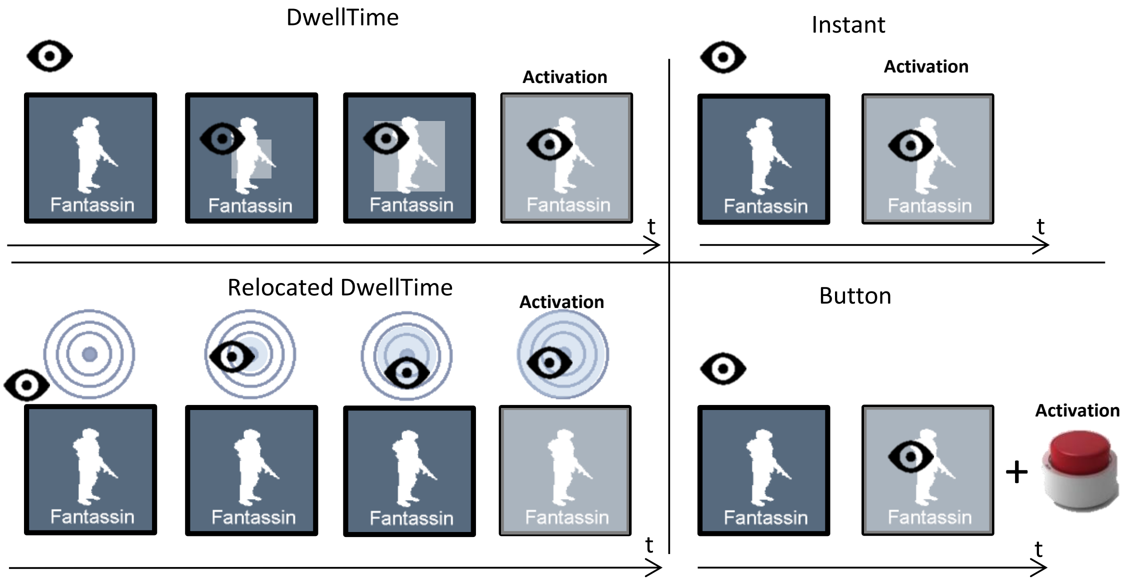


Figure 2 : Interaction modalities and associated feedbacks. In reading order: DwellTime (DT), Instant activation (I), Relocated DwellTime (RD) and multimodal button + gaze (B).

## 2.3 Menu Design

Two menus were proposed to the user: a linear menu and a circular one. Menus were designed with similar item sizes of approximately 1.5° when the user is the farthest from the screen in order to ensure the usability of the eye-gaze. The minimum space between two adjacent items was approximately 0.2°. This implies a minimal distance of 1.7° between the centers of closest items (cf. Figure 3)

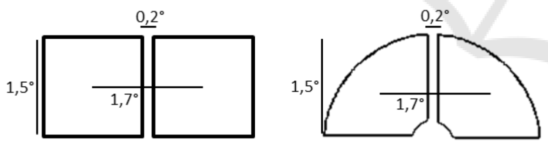


Figure 3: Size and spacing design of menu items.

Each characteristic is represented by an icon just above the textual information. The closure of a sub-menu can be done by selecting an item, by looking away from the menu for more than 0.5s, or by opening another sub-menu.

*Linear menu:* The linear menu is composed of a horizontal sequence of square-shaped items with a narrow separation between them. The sub-menus open above the main menu and are horizontally centered on the opened main item that triggered the opening. Two lines play the role of visual indicators to help the user control the opened main-item. The opening upward is arbitrary; it may remind of the presentation of opened applications on a Windows environment for example (cf. Figure 4).

*Circular menu:* The main menu is composed of four items disposed with N, S, E, W orientations while the sub-menus have orientations following the NE, NW, SW, SE directions. The center of sub-menus is located in the continuity of the item direction so that the selected main item is hidden behind the sub-menu, just like in a marking menu.

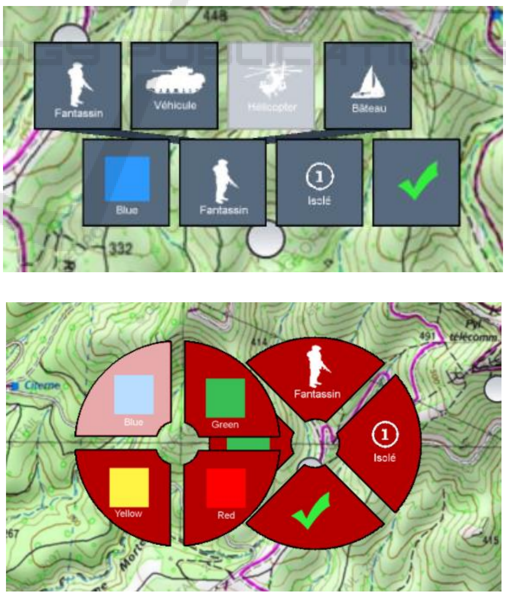


Figure 4: Two-depth-levels linear menu opening upward (top) and circular menu (bottom).

## 2.4 Experimental Task

The experimental task consists in selecting three characteristics (color, approximate number and type) of objects presented on a picture (e.g. Figure 5) before validating the selection. This experimental task is representative of the operational task presented above. Selecting the characteristics is done using the menus presented in Figure 4. The opening and the selection in a sub-menu are done using one of the four presented modalities which vary during the experiment. Current active choices are showed on the main menu to give the user the possibility to control his/her choice.

Figure 5: Example of a picture where the user has to specify the three characteristics (color: red, number: 10 or more, type: helicopter).

## 2.5 Material

As no totally isolated room could have been booked, the experiment was conducted in a calm open-space with very little transit. The user was facing a 15 inches laptop with a resolution of 1920x1080 at a distance of approximatively 55cm. Neither the screen nor the user was affected by glint or light surplus. The eye-tracking system was a Tobii Eye-X. The “space” key of the computer keyboard was used for the “Button” modality.

Outside of the visual field of the participant, a second screen was set up to allow the operator to visualize the eye-movement of the participant. This was done using the “OBS Studio” application coupled with the “Streaming gaze overlay” provided by Tobii. During verbal feedback, participants were filmed with a small Panasonic camera if they agreed.

## 2.6 Experimental Design and Procedure

First, a filling form was presented to the participant to collect individual data. The subsequent form which aimed at getting feedback of their experience was presented before the experiment in order to avoid them discovering it after the first test.
Then the user was asked to calibrate the eye-tracking system and the task was presented together with the first interaction modality.

The experiment followed a 4x2 (independent factors) model: the first dependent factor was the interaction modality, taking value in the whole of the four interaction modalities presented above {DwellTime, Relocated DwellTime, Instant, Button} while the second dependent factor was the menu shape, taking value in the set {Linear, Circular}. Each participant passed the whole 8 tests. The order was randomized this way: first the order of modalities was selected, and then for each modality, the first menu to pass the test on was also randomly picked. None of the combinations was identical to another.

Each of the 8 tests consisted in a learning phase of the modality on the subsequently asked task during 1 minute. At the end of this timer, if the user was able to make 2 successful tasks in a row, the actual test would start. Otherwise he/she could take another minute to get used to the modality and the menu shape. The first learning phase was longer as the operator also had to explain the task. Then the test consisted in 12 realizations of the experimental task in a row, no matter the results of the user. After each couple of tests (representing one of the modalities), the user was asked to verbalize his/her feelings about the modality and was asked to fill a form with subjective values about the intuitiveness, the perceived speed, the effort needed or the reliability of the modality. A mark on 20 (standard French scale) was provided for both kinds of menus with this interaction modality. Larger values mean a better overall feeling about the modality. This non-classic scale was used because French people are used to it. You may interpret it as a Likert rating scale where 0 means “very bad” and 20 means “very good”.

No specific indication on how to do the task was given to the participant, and the order of the characteristics to specify was up to him/her. The only indication given was to try to be “efficient”, with the meaning of this word let to the user’s interpretation.

### 2.7 Measured Variables

As mentioned before, verbal feedbacks were collected at the end of the use of each modality. They were used to understand how the users felt about each interaction modality and the adequacy with each of the menus. At first they were free to give their feedback and then they were encouraged to give more information.

A form allowed collecting qualitative data about perceived characteristics, namely the intuitiveness, the perceived speed, the reliability and the effort needed to interact. The users were asked to grade each characteristic on a 7 -ank Likert scale (the 7-rank choice was made accordingly to Symonds' work (Symonds, 1924)) where 1 meant, for example, not intuitive at all and 7 meant very intuitive. Then the users marked the modalities on 20. The data are presented as mean ± SD.

Quantitatively, only the time spent looking on the interface per activation was analyzed. This time is representative of the efficiency of the modalities and excludes any complexity implied by the picture presented to the user.

Subjective results were analyzed using non-parametric statistical tests. First, results were analyzed by pairs (only the Menu dimension varied) using Wilcoxon's matched-pairs signed rank test to look for interaction effect of the type of menus on the modalities appreciations. Then, only the modality dimension was looked at using Friedman's test to look for a main effect of modality on results. A post hoc analysis on the modality dimension was carried out using Dunn's multiple comparison tests. Quantitative data (activation time) were analyzed using two-way ANOVA for repeated measures on the logarithm of the time although results are presented in a linear scale for clarity.

## 3 RESULTS

### 3.1 Intuitiveness

None of the pairwise Wilcoxon signed rank tests shows any effect of the menu type on perceived intuitiveness (all $p > 0.05$). None of the modalities was more intuitive on one type of menu than on the other. But letting the influence of menus apart, Friedman tests show a significant effect ($p < 0.0001$) of the modality on the perceived intuitiveness, showing all the eye-gaze based interactions are not perceived in the same way.

Button (B) and DwellTime (DT) interaction modalities show no significant difference ($p > 0.05$). Same goes for Instant (I) and relocated DwellTime (RD). However these two groups (Button-DwellTime vs Instant-Relocated DwellTime) show significant differences from each other (all four pairwise p values < 0.05).

Contrary to our expectations, circular menus seem much more intuitive than linear ones, even if linear menus are more common. Some users feel uncomfortable watching non-semantic items (the target) to interact with while using Relocated DwellTime. They mentioned they preferred (or would prefer if they did not already use DwellTime) to interact using any of the other presented modalities where they directly fixated the item. The Instant modality bothered some users, mainly because of the central position of the menu during the task. This shows the *MidasTouch* effect once again.

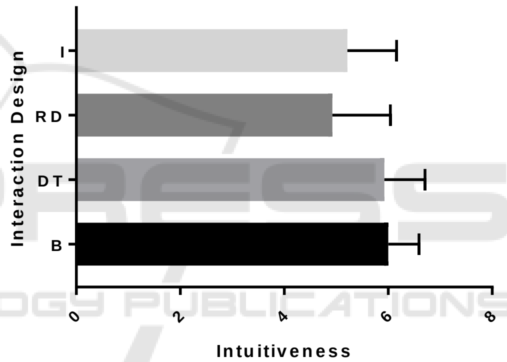


Figure 6: Intuitiveness mean by interaction modalities.

### 3.2 Activation Speed and Perceived Speed

Pairwise Wilcoxon signed rank tests show no impact of the menu type on the perceived speed by the user (all $p > 0.05$). Thus no interaction modality felt faster on a menu type than on the other. The impact of modalities was analyzed by merging data from both kinds of menus. Friedman test shows a significant effect of interaction modalities on perceived speed ($p < 0.001$). Post hoc analysis shows that only the Relocated DwellTime modality is significantly different from each of the others modalities. It is particularly striking in comparison with the Instant or Button modalities ($p < 0.001$) while it is less obvious against DwellTime ($p = 0.02$). Relocated DwellTime scores 1.2 point less on average than Instant and Button (0.8 less than DwellTime). Users say that having to stay focused on fixating a point seems long; they feel they are waiting for the interface to respond. This felt even longer with Relocated DwellTime as there is an additional step.

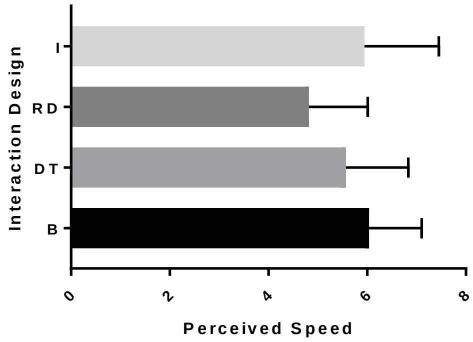


Figure 7: Perceived speed by interaction modalities.

With quantitative activation times, RM-ANOVA shows an interaction effect of menu types on modalities. Relocated DwellTime on linear menus is significantly ($p < 0.05$) faster, by 0.5s (around 12.5% of the activation time for these modalities). But this change was not perceived by users. It also shows a significant effect of modalities on execution times. Indeed, Relocated DwellTime is significantly slower than the three others modalities by about 1.3s (all 3 p-values < 0.001). This is consistent with the perceived speed. Contrary to our expectations, Button and Instant interactions are not faster than DwellTime.

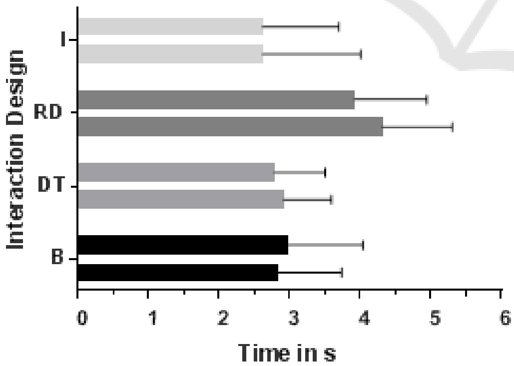


Figure 8: Activation speed. Time spent looking at the interface until one characteristic is selected. The upper bars represent results on linear menus, while the lower represent circular menus.

## 3.3 Reliability

Contrary to other variables, the Wilcoxon test shows a significant effect of the menu on the perceived reliability of DwellTime ($p < 0.01$) and for DwellTime only (other p-values > 0.05). An explanation was quickly highlighted: this is due to the fact that the sub-menu superimposes the main menu for the circular design (cf. Figure 4). This implies that the waiting time of one of the sub-menu items hiding the main menu starts just as the menu opens, even before the user processes this opening. This has no impact on other modalities as they either need the user to press a button or to look further to activate any item. So this result is probably more due to a design difference than to a real impact of menu type. Because of that, the others statistical tests were performed considering only DwellTime data coming from linear menus. By doing this, Friedman and Dunn's tests do not show any effect of the modality on the perceived reliability. Our hypothesis was that the Button and Relocated DwellTime interaction modalities would make the user feel more in control, because of the explicit activation step. Results do not reflect this, as every modality is perceived to be as reliable as the others, except for the point mentioned before.

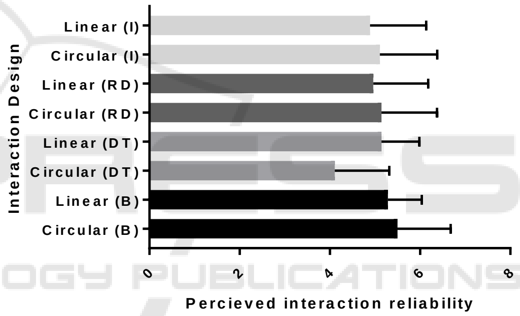


Figure 9: Perceived reliability for each interaction design.

## 3.4 Effort Needed during the Interaction

As for the intuitiveness, Wilcoxon tests show no impact of the menu type on perceived effort (all $p > 0.05$). The modality shows no main effect to the perceived effort using Friedman tests. Moreover, almost all pairwise comparison between modalities show no significant results except for the comparison between Relocated DwellTime and Button which is significant ($p=0.05$) with a means difference of 0.6 point. This was verbalized by users as the need to do an additional step for Relocated DwellTime. As for intuitiveness, it demands more effort to look at a non-semantic item. For 3 participants only, the Instant modality felt difficult because they could cut themselves off from the opening of menus and "had to" look through the recently opened menu. It made it very difficult for them to check for already selected characteristics for example. This was more verbalized for linear menus as the design makes it harder to identify the opened menu without looking at it, since it almost appears in the same place.

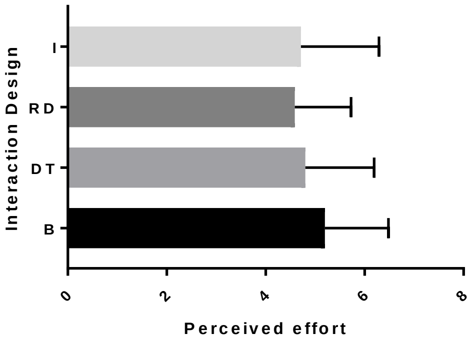


Figure 10: Perceived effort using the interaction modalities. Upper score means less effort.

### 3.5 General Appreciation

Considering general appreciation (ranking on a 20 point scale), no impact of menu type proved to have significant influence (all four p-values < 0.05 for Wilcoxon tests). Thus, only the interaction modalities were studied. Only the Button modality showed significant advantages over the three other modalities ($p < 0.05$), scoring an average of about 1.4 point over the other modalities.

Figure 11 shows both the intra-user and inter user influences. First, it shows that users who positively mark modalities on linear menus do the same for circular ones (value points are located near the first diagonal). It seems a bit less true for modalities as users tend to prefer one type of modality over the others (here Instant and Button were grouped as button-based modalities, whereas DwellTime and Relocated DwellTime were as dwell-based modalities). The interpretation must consider these two groups of people.

Secondly, user marks range from about 12 to 17, showing inter-user variability and account for onsidering the user as a random effect on the model.

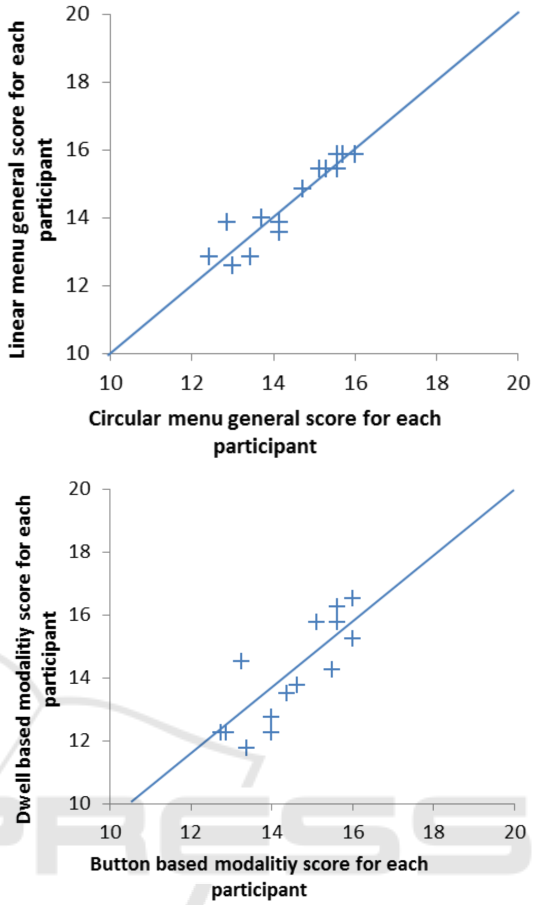


Figure 11: Inter and intra user variability. Circular vs. linear appreciation (top). Button based vs. Dwell based interaction (down).

## 4 CONCLUSION & DISCUSSION

Knowing the previous work on linear and circular menus, we conceived an experiment to evaluate user perception of these menus with four different modalities in an operational context.

Contrary to what we expected, we found no impact of the menu shape on preferences or performances of any of the four tested modalities. The only significant effect (on DwellTime) was very likely due to menu superimposition. However, this was done using restricted design. Indeed, button size and inter-button distances were similarly fixed, and the tested interaction modalities were the same on both types of menu. In practice, circular menus might have assets that were not exploited in our experiment. For example, as buttons are spread from the center, button size could be decreased or other interaction techniques could be developed only for circular designs. This could lead to results similar to those presented in (Kammerer, et al., 2008). But our aim was to evaluate modalities on already existent interfaces (very similar actually) in order to evaluate the integration of eye-gaze based modalities in existent systems.

While no effect of the menu was highlighted, interaction modalities were considered differently by users. In general, the multimodal modality using a button in addition of the gaze was more appreciated and performed better than the others. While in pre-experiments the instant opening showed great results (menus were on the edge of the screen at that time), it did not perform that well, both in terms of appreciation and speed. Some of the users did not even see the difference between Instant and Button. This is probably good news as it does not totally exclude the instant opening from interaction modalities.

We designed Relocated DwellTime in order to provide control to the user but in practice, users did not mark Relocated DwellTime that way. The theoretically added control was balanced by the added complexity of the modality. The expected extra control could probably be more visible with a task where the user must analyze the interface more deeply.

It is important to note that the experiment was conducted by novices. If the task itself was easy enough to let us consider users were expert in the main task, they were not expert in using the eye as an interaction medium. It is important in further experiment to consider having users more experienced with eye based interactions to compare tendencies.

For a military task such as characterizing a point, it seems that the Button interaction would be more adapted, giving the user more control with the interface over the task flow at very little cost. Choosing between a circular and a linear menu should be done considering the impact on the task rather than on the interaction modalities.

## REFERENCES


Callahan, J., Hopkins, D., Weiser, M. & Shneiderman, B., 1988. *An empirical comparison of pie vs. linear menus.* s.l., s.n., pp. 95-100.

Hansen, J. P. et al., 2003. *Command without a click: Dwell time typing by mouse and gaze selections.* s.l., s.n., pp. 121-128.

Jacob, R. J. K., 1993. Eye movement-based human-computer interaction techniques: Toward non-command interfaces. *Advances in human-computer interaction,* Volume 4, pp. 151-190.

Kammerer, Y., Scheiter, K. & Beinhauer, W., 2008. *Looking my way through the menu: the impact of menu design and multimodal input on gaze-based menu selection.* s.l., s.n., pp. 213-220.

Kourkolis, M., 1986. APP-6 Military symbols for land-based systems. *Military Agency for Standardization (MAS), NATO Letter of Promulgation.*

Kurtenbach, G. P., 1993. *The design and evaluation of marking menus,* s.l.: s.n.

Leigh, R. J. & Zee, D. S., 2015. *The neurology of eye movements.* s.l.:Oxford University Press, USA.

Liebling, D. J. & Dumais, S. T., 2014. *Gaze and mouse coordination in everyday work.* s.l., s.n., pp. 1141-1150.

Lutteroth, C., Penkar, M. & Weber, G., 2015. *Gaze vs. Mouse: a fast and accurate gaze-only click alternative.* s.l., s.n., pp. 385-394.

Møllenbach, E., Hansen, J. P. & Lillholm, M., 2013. Eye movements in gaze interaction. *Journal of Eye Movement Research,* Volume 6.

Samp, K. & Decker, S., 2010. *Supporting menu design with radial layouts.* s.l., s.n., pp. 155-162.

Surakka, V., Illi, M. & Isokoski, P., 2004. Gazing and frowning as a new human--computer interaction technique. *ACM Transactions on Applied Perception (TAP),* Volume 1, pp. 40-56.

Symonds, P. M., 1924. On the Loss of Reliability in Ratings Due to Coarseness of the Scale. Dans: s.l.:s.n., p. 456.

Tall, M., 2008. *Neovisus: Gaze driven interface components.* s.l., s.n., pp. 47-51.

Urbina, M. H., Lorenz, M. & Huckauf, A., 2010. *Pies with EYEs: the limits of hierarchical pie menus in gaze control.* s.l., s.n., pp. 93-96.

Vidal, M., Pfeuffer, K., Bulling, A. & Gellersen, H. W., 2013. *Pursuits: eye-based interaction with moving targets.* s.l., s.n., pp. 3147-3150.

Wikipédia, 2017. *APP-6A --- Wikipédia, l'encyclopédie libre.* s.l.:s.n.

Zander, T. O., Gaertner, M., Kothe, C. & Vilimek, R., 2010. Combining eye gaze input with a brain--computer interface for touchless human--computer interaction. *Intl. Journal of Human--Computer Interaction,* Volume 27, pp. 38-51.

Zhai, S., Morimoto, C. & Ihde, S., 1999. *Manual and gaze input cascaded (MAGIC) pointing.* s.l., s.n., pp. 246-253.