Rhythmic menus: toward interaction based on rhythm

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ABSTRACT
In this paper, we evaluate an interaction style based on visual and auditory rhythms. We describe this rhythmic interactor and experimentally compare it to the pull-down menus found in current graphical user interfaces. The main result is that, for short and medium length menus, sound-enhanced rhythmic menus are faster than pull-down menus.

Keywords
Human performance, interaction design, auditory and visual rhythms.

INTRODUCTION
In traditional interface design, choosing an item in a menu entails a pointing or a dragging action. As shown by MacKenzie and Buxton [2], this can be modeled by Fitts' law. Using knowledge about this law, there have been suggestions to improve pointing performance. For example, Walker *et al.* [1] prescribe changes in target shapes and online feedback for menu operations. However, all these menus convey an important visual load, that is not suitable in all contexts. This paper explores another direction to improve item selection: time and rhythm. We evaluate an attempt to translate a spatial pointing (traditional pointing task with two parameters: target size and distance) into a temporal pointing where accuracy depends only on one parameter: temporal target size, thus theoretically reducing attentional load and/or selection time.

Actually, even though they often go unnoticed, we are often exposed to delay and rhythm-based interactions: time tuning in digital watches, codes for entering safe rooms, automatic windows on some cars, etc. Many computer games also use similar interaction styles. However, so far little data was available about their efficiency as compared to traditional menus: we feel them as comfortable, but are they efficient enough? To that purpose, we designed rhythmic menus and experimentally compared their performance with traditional pull-down menus.

RHYTHMIC MENUS
Rhythmic menus, directed to skilled users, can be used to replace pull-down menus under certain conditions. In a conventional pull-down menu, pressing the mouse button in the menu titles activates the menu. To select menu items, you have to move the mouse to the desired item and release or click on the button.

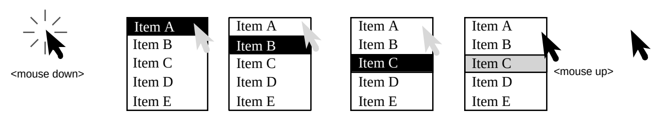

Figure 1: A selection with a rhythmic menu. Item C was selected.

In rhythmic menus, menu invocation is similar but menu item selection has been modified. Users are not required to move the mouse in order to change the highlighted item: once the menu opened, the system highlights each item in succession at a constant rate. When an item is highlighted, users can click anywhere on the screen to select it. Figure 1 shows an example of menu selection using a rhythmic menu.

Considering that the perceptual system best suited to the temporal dimension is the auditory system (because it has the least inertia and follows closely high frequency stimuli), our menu design rests largely on the use of sound and on the natural tendency of the human system to follow a rhythm. As a consequence, the attentional load necessary to operate our menus should be substantially decreased.

In the experiment described in this paper, we have compared this kind of interaction with traditional pull-down menus. We have tested several versions of rhythmic menus in order to explore the effect of auditory versus visual rhythms in terms of efficiency and error rate.

EXPERIMENT
Design and Procedure
Subjects were seated in front of a 17" monitor and wore infrared headphones. Eleven subjects took part in the experiment. All were experts in using traditional menus.

The task was a simple menu selection task. The program presented a letter in the middle of the screen. Users had to click anywhere on the screen to activate the menu (thus starting time measurement) and select the right item, either by moving the mouse down on the menu (standard menu condition) or by waiting until the item was highlighted (rhythmic menu condition). In both cases, item selection was performed by releasing the mouse button.

In this experiment, we have varied three parameters: the rate at which items were highlighted (switching rate), the use, or not, of sound each time the highlighted item was changed and the number of items in the menu.

A particularity of the rhythmic menu design is that the selection time is a direct consequence of the item switching rate. Hence the necessity to choose a rate that is a good compromise between a short selection time and an acceptable error rate. We compare here results from three different rates corresponding to selection times of 180, 160 or 140ms, that were chosen empirically.

In order to assess the efficiency of visual versus auditory input, we compare a purely visual version of rhythmic menus with two versions using the addition of sounds. The basic sonification uses the same short sound (12ms) for each item. In a further version elaborated in order to reduce common errors committed when selecting the second item, we have implemented a different sound and a longer highlight duration for the first item.

The number of items was varied in order to see how the length of the menus could differentially influence rhythmic and standard menus. Thus, we have used menus with 5, 7 and 9 items. For every configuration of test, the program presented, in a random fashion, six repetitions for each item.

As a preliminary requirement, users were trained to use rhythmic menus with different switching rates during four 10min sessions. The experiment was then divided into four different sets corresponding to the type of menu tested: traditional pull-down menu, rhythmic menu without sound, rhythmic menu with the same sound for all items and rhythmic menu with a different sound for the first item. Inside each set, subjects were tested using first the slowest switching rate (180 ms), then the medium one (160 ms) and lastly the fastest one (140 ms). For each switching rate, the number of items (5, 7 or 9) was randomized.

Results and Discussion

For each dependent variable, a within-subjects with repeated measures analysis of variance was performed.

# of items, switch rate	pull-down menu	rhythmic menu	basic sound rhythmic menu	elaborated sound rhythmic menu
5 items, 180ms	0.76s *(0.7%)*	0.52s *(4.4%)*	0.54s *(3.3%)*	0.53s *(3.3%)*
5 items, 160ms		0.47s *(4.0%)*	0.47s*(1.8%)*	0.47s *(0.7%)*
5 items, 140ms		0.43s *(7.0%)*	0.42s *(1.8%)*	0.42s *(2.5%)*
7 items, 180ms	0.93s *(0.2%)*	0.72s *(5.0%)*	0.71s *(1.8%)*	0.72s *(2.1%)*
7 items, 160ms		0.65s *(3.4%)*	0.65s *(1.8%)*	0.65s *(1.0%)*
7 items, 140ms		0.59s *(6.8%)*	0.57s *(3.1%)*	0.57s *(2.3%)*
9 items, 180ms	0.95s *(0.4%)*	0.92s *(5.5%)*	0.91s *(2.6%)*	0.94 *(1.6%)*
9 items, 160ms		0.82s *(3.7%)*	0.82s *(3.2%)*	0.81s*(2.4%)*
9 items, 140ms		0.71s *(6.7%)*	0.74s *(4.3%)*	0.74s *(4.3%)*

Table 1: Mean selection time and error rate for menus with 5, 7 or 9 items, switching rates with periods of 180, 160 or 140 ms and for each menu version, averaged over subjects and repetitions.

Selection time

The first variable presented here is the selection time, i.e. the time necessary to select any given item.

The difference between rhythmic and standard menus is significant ($p < .001$) for every kind of rhythmic menu. As can be seen on Table 1, at the highest switching rate (period = 140ms) selection time with rhythmic menu is about 42% shorter than selection time for standard menu for 5 items, 39% for 7 items and about 24% for 9 items. This difference decreases with the switching rate and number of items in the menu; for example, with a period duration of 180ms and 11 items, selection time for rhythmic and standard menu is almost identical.

Error rate

The second variable measured is the number of selection errors made by users.

Although the error rate is generally higher for rhythmic menus (between one to seven times higher), it decreases significantly ($p < .005$) when sound is used.

The better results with the sound confirm observations we made in a previous experiment where we found evidence that subjects have a better rhythm synchronization when they can hear the rhythm (as opposed to only see it).

FUTURE WORK AND CONCLUSION

In conclusion, our evaluation of rhythmic menus shows that for usual numbers of items, they perform comparably or better than pull-down menus. Error rates are greater but can be minimized by tuning the switching rate and the audio feedback. If, indeed, rhythmic interactors can be shown to reduce cognitive load while being at least as efficient, this interaction style will be worth exploring further.

The follow-up of this ongoing work is twofold. On the experimental side, we are fine-tuning the temporal sequences of these menus to take into account perceptual, motor and psychological idiosyncrasies (i.e. differences in processing times for visual versus auditory). We also are exploring more systematically the design of sound feedbacks. On the application side, these menus are tested while incorporated in a real application used every day (a text editor) to determine how error rates evolve over time.

As stated in the introduction, there are theoretical reasons to believe that rhythmic interactors entail less cognitive load than standard selection tools. This aspect could be very important when the user has to keep in mind a complex and evolving context. However, this claim needs to be experimentally verified.

REFERENCES

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