Memorizing Rhythms – an enhanced knot in the handkerchief

ABSTRACT
This paper takes a look at how the ability of remembering things or data can be enhanced by the act of deliberately performing an action with a tangible user interface (TUI). It proposes a portable shape-changing TUI that merges input and output in one device. As a reminiscence of the "knot in a handkerchief", the idea is that the function of reminding the user works without invasive feedback such as sound, vibration or visual displays. Instead the object is compressible and thus uses rhythms of swelling and shrinkage. As for putting the made assumptions to test, subjects had to use the device and "feed" it with a certain amount of data that was to be remembered and were tested what they could recall after determined spans of time.

Author Keywords
Tangible user interface, shape change, memorizing

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Design;

INTRODUCTION
In the last couple of years the preferred way of memorizing appointments has drastically changed. In former times one would have used a physical calendar or notebook, now we use computers and smartphones to create appointments and we get audiovisually reminded when the appointment comes up. There is no longer a physical object or place of fixed size where our appointments are stored, instead the place where we put them is at the same time used for innumerable other things such as staying in touch with friends or tracking the stock exchange. Thus the physical act of memorizing something has almost disappeared by now. Even though already long ago people started to use physical artifacts to help them recall data, for example the familiar knot in the handkerchief. Therefore the idea was to take the concept of the knot in the handkerchief and enhance it with the digital means we have nowadays. It should be more than an indicator that there is something to recall, but would tell if there are different things to memorize and what these are. However the prototype ought not to have a display or buttons or invasive feedback like sound, but should function only with the kinetic means of a tangible user interface. After some research on what already existed in this field, we built a prototype according to our specifications and evaluated it in a user test that created some interesting insights.

RELATED WORKS AND RESEARCH
In recent years we observed a raising number of explorations concerning kinetic interfaces using movement as information display.
The motions in kinetic interfaces can be used to display information based on various principles. Roughly these forms can be categorized into three areas:

Firstly emotions are expressed through, like Rasmussen names them, "life-like" [1] motions as in Outerspace [2], Thrifty Faucet [3] or Ambient Life [4]. In most cases these emotions can be interpreted by the user in the context of the device.
Secondly there can be direct communication – applying motion/shape change in the context of the device, also called "indexical" by Joost et al. [5]: For example a thicker body of the device means more content e.g. received messages in the mobile phone as in Dynamic Knobs [6].
And there are symbolic approaches, where the shape change is either transforming the device into a new symbol as e.g. in the by Coelho and Zigelbaum only on a theoretical level discussed reshaping of a donut into a cup [7] or transforming an object into a readable symbol as text as in "Shutters" by Coelho and Maes [8].

All these examples have a pre-defined form of kinetic information display, designed by the inventor or designer of the specific kinetic interface.
We however were interested in observing user-generated motions to communication information in kinetic interfaces.

Only few explorations concern user-generated forms of information display in kinetic interfaces. With Topobo [7] Parks explores how kinetic memory can be used in an educational context, however more focussing on "movement and animal locomotion" than a kinetic language for information display, which is our main interest in this project.

Due to what Norman [10] says about cognitive artifacts, ("an artificial device designed to maintain, display, or operate upon information in order to serve a representational function") namely that these "change the nature of the task performed by a person" and that the "result is to expand and enhance cognitive abilities of the total system of human, task, and artifact.", we specifically wanted to find out what subjects would make out of our idea to use a kinetic interface for memorizing.
Furthermore, if they would develop certain strategies to build up their own kinetic language using the prototype as a memory aid in order to integrate it in their ways of memorizing things.

In her paper about the use of memory aids in everyday life, Klumb [11] shows a table with criteria describing certain qualities that Reason [12] assembled for the evaluation of memory aids. It says that a knot in the handkerchief has a low value in the criterion "content" but high value in the criterion "convenient". In our project we seek to enhance the knot in the handkerchief by raising the amount of content it can hold and play back to the user.

Another project that aimed to design an enhanced memorizing artifact is the "Tangible Reminder" [13] by Hermann et al. It is meant to work as an ambient reminding device that has trays to put in things of everyday life that work as memory aids and get "packed" with data to be memorized. After being put in one of the trays, the reminder uses different intensities and colours of light to show when an appointment comes up.

However, while we liked the idea of ambient reminding and the tangible aspect, we were disappointed that for defining the appointment the Tangible Reminder still uses a conventional screen interface where you enter the details of your appointment with a touch stylus.

We though wanted to limit ourselves exclusively to tangible means to remain as close as possible to the idea of the knot in the handkerchief, that works with solely tangible input (tying the knot) and without any intrusive feedback.

DESIGN

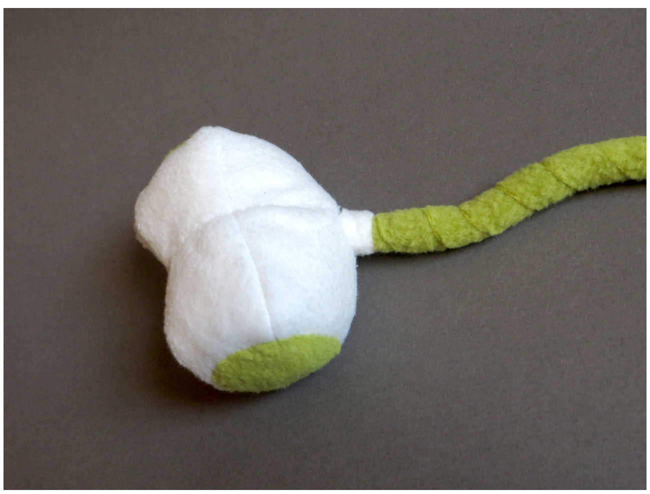

Figure 1. The prototype

The device consists of a corpus that measures 11cm (full length) respectively 9 cm (contracted) in length and 7 cm in diameter. This corpus is connected to an Arduino Uno Microcontroller [14].

Inside the fabric casing there is a micro servomotor padded with foam that moves two gear racks via a gear wheel counterwisely as linear actuators. At the end of the gear racks there are round pads of paper clay attached of which one has an FSR (Force Sensing Resistor) mounted on it.

When the FSR senses pressure, the pads move accordingly so that an illusion of contracting the device via pressure is generated. When the pressure is removed, the pads move back to their original state, which represents the full volume of the device. In the mode of playing back the input of the user, the device contracts exactly in the way the user has done before. Therefore when the user records a pressure rhythm and the device is playing back their rhythms of contractions afterwards, the device works as both input and output.

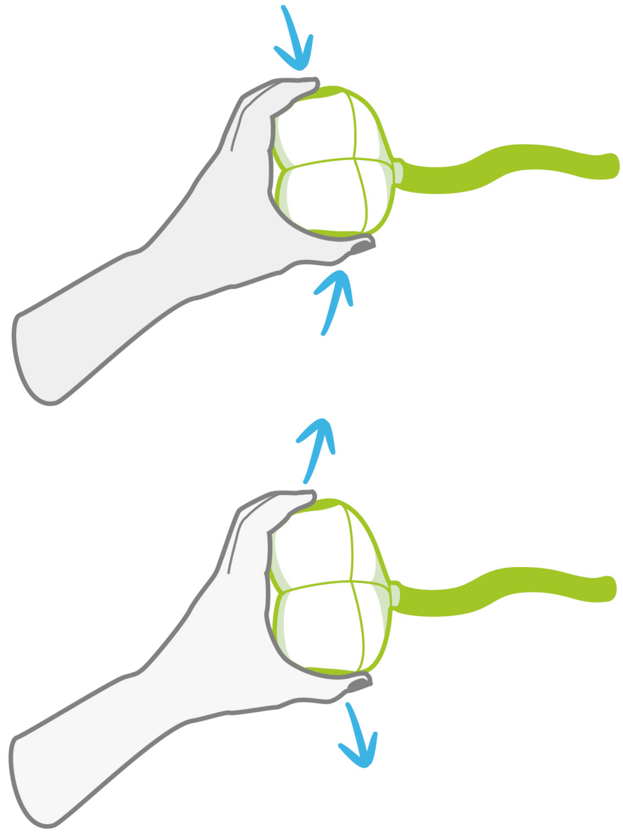

Figure 2. The process of giving input via pressure

USER TEST

The prototype was informally tested by six persons between 25 and 53 (1f,5m). The user test itself contained 8 appointments of everyday life that the subjects ought to remember. These were: Grocery shopping, making an appointment with the physician, planning the summer holidays, cancelling the visit at the parents' in law, repairing the bicycle, mowing the lawn, doing their taxes, watching a football match on TV.

After being explained the device, the subjects were read one appointment at a time that they ought to memorize. Then they had to put a rhythm or non-rhythmic pressure into the device. That input was being recorded. The test-subjects were randomly divided into two groups with 3 members each: One group had to come back to take the second part of the test after 6 hours, the other half was told to come back after 24 hours.

For the second part of the test, the subjects were played their input one at a time and had to recognize what appointment was assigned to it. Through the whole test, the subjects had to think aloud, i.e. to tell me about their modus operandi.

RESULTS

None of the subjects had knowledge or experience in the field of interaction design or of cognitive psychology. Regardless they had no problem whatsoever understanding quickly how the device works and how to handle it properly. They found it positive that the device is soft to the touch.

Already at the very start of the test, after the subjects were told about the proceedings, two groups formed. The first group (3 subjects) wanted to start with the first task right away, the second group requested time to think of a system they could use in the following.
The first group thus acted spontaneously and chose rhythms that came to their mind hoping they would remember them afterwards or established a system how to memorize the appointments in the proceeding of the test.
The second group (3 subjects) that had constructed their memorizing systems beforehand, needed more time in general to put a rhythm into the device, because for each appointment they tried to apply their system. Some realized that their system didn't work while some had no problems to apply their system to each appointment.

Subject	type of system	Number of memorized appoint-ments	Applic-ability of system (if existing)
1	No system before the test	7	/
2	appointment divided into quick/short and slow/long parts	7	high
3	scales from high to low (financial value, work or privacy related)	2	low
4	No system before the test	1	/
5	No system before the test	3	/
6	each appointment translated into a rhythm that fits a mental image	8	high

Table 1. subjects, their systems, if any, and the applicability of their systems

Examples for constructed systems:
One subject based their system on a scale of mental and financial value (high value = high pressure, low value = low pressure) and a scale from work-related to privacy-related for the rhythm's speed.

Another subject was thinking of images that were translated into rhythm (mowing the lawn = many blades of grass = many short appliances of pressure).

A third subject was dividing the appointment in parts of different tempi (appointment at the physician = quick drive, long wait, quick examination makes a rhythm of short-long-short).

It turned out that a non-applicable memorizing-system or a system that applies to only some of the appointments lead to the same low number of recalled appointments as when the subject had no system from the start. Thus the results of the test are not meaningful in terms of how many appointments subjects can memorize via rhythms.
Instead, it reports on the importance of a well applicable system and that the subjects need time to think of a system. The number of memorized appointments accordingly varied between one and eight (1 subject with 1, 1 subject with 2, 1 subject with 3, 2 subjects with 7, 1 subject with 8 memorized appointments) with low results for subjects with a non-applicable system and high results for subjects with a system that was well applicable for every appointment.

For a significant test on how many appointments subjects can memorize, a training phase is necessary where subjects can construct different systems and prove if they work for them and if they are applicable.

CONCLUSION

Cognitive artifacts for memorizing are in use since long time ago. Our prototype as a digitally enhanced form of the knot in the handkerchief could be a non-intrusive kinetic alternative or extension to common calendar applications or to-do-lists.

By building the prototype and conducting a user test we found out that the subjects found the prototype easy to use.They thought there was a certain joy of use as well.

Furthermore, through the user test itself we gained valuable insights that users construct strategies for their act of memorizing things and that those strategies and the strategy of building them up varies vastly from user to user. Maybe it would be useful to identify the best strategy and implement it into our system.

OUTLOOK

For more insights into the actual functionality of the device and how it would be integrated in the daily routine of persons who would use it as a memory aid, further work on the prototype is necessary to make it even smaller, so that it will fit e.g. into trousers' pockets or on a key ring. Moreover it obviously would have to be wireless to be able to be carried around.

At this state it would be possible to conduct really meaningful and probably enlightening user studies. The users could get used to having a memorizing artifact with them and take their time to construct systems that apply to appointments of their specific needs and habits. It's a matter of fact that normally, cognitive artifacts are indeed not used under laboratory conditions, but in the daily life of people. One could observe what kind of systems the users construct for their appointments, or if they even have different systems for different kinds of data they want to remember. Besides we need to investigate whether such a system works for rather prompt appointments/reminders or if it also can be applied for appointments in the far future.

Further research is also required to identify a suitable interaction paradigm as e.g. for identifying the right point in time for reminding users or the right integration of such a system into existing solutions

ACKNOWLEDGEMENTS

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