Heart-rate Response to Simulated Anxious Events

Development of kids' friendly wearable device for children's safety

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Abstract: This study aims to know how and when small children between 1 to 6 years, feel anxiety during their daily lives. Pre-school children are our target to be kept them from crimes and accidents while they are taken care in the nurseries or kindergartens or on holidays by any responsible persons. This is basic research for designing a wearable device for children's safety. We made several simulated anxious situations as movies and facial emotion images to show to kids in a set of room. We found depends on the ages or personal experiences, children's reactions were different and anxiety was shown up differently.

Key words: Kids safety, anxiety, heart-rates, simulated events, sharing information.

1. Introduction

This study was set up as a basic research for developing a wearable device for children's safety in a local area. There are many of crimes or accidents targeted to little children in many countries recent days. Particularly under 6 year old children (kindergarten ages before primary school), they have little ability on verbal communication with people even with their parents. And recently in increasing working mothers, they are apart from their children during day time. Some of kindergartens in Japan or other countries, they serve a security camera in the classrooms when children are in. Mothers want to know how their children are spending their time at the kindergarten but many of them don't want to keep watching them or teachers without any interaction. We found this through a survey of answer sheets in 2005 about children's safety [1]. Parents want to know what their children think about daily events and any unconscious behaviors or anxiety.

The final goal of this study is to know how children react to anxious or dangerous events for designing a wearable device can detect children's heart-rates and movements with wireless sensors. The device will offer only in-front views when children feel anxious or big changes of movements or heart-rates detected from the sensors. This study aims to know when and how the children show anxiety through heart-rates by simulated movies and facial emotion images. This study is to make sure the development of wearable device with functions of detecting physiological data such as movements and voices of children to prevent them from any potential possibilities of crimes and accidents.

2. Methods

2.1. Set of the experimental room

The experimental room was set up with a big screen (200x150cm) and a projection and ECG equipments. This room was big as 5x5(m) and with Tadami floor to make people get rests or experiments at the university. It is easy to concentrate to the movies in this small space. ECG equipments were set up behind the subjects' seat not to be seen by subjects. For younger aged children between 1-2 years, mothers could stay with them in the room during the experiment. Children have two electric bandages on their chests, one on their chest and the other behind of their waist to be positioned across the heart (Fig.1).

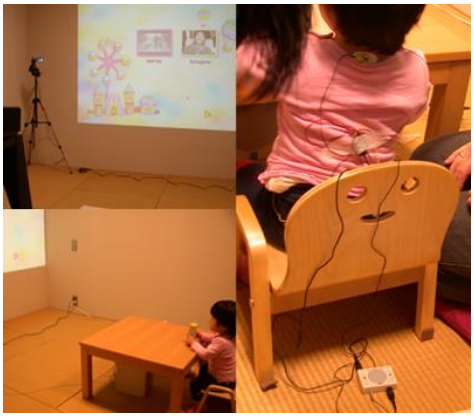


Figure1. Experimental room

2.2. Set of simulated images

Simulated events movies

To know the reactions of heart-rates from 1 to 6 year-old children, it was not possible to make real situations to them. So, we had to set up a series of simulated events as movies. 11 simulated movies in total were prepared which can be divided into four categories, such as, nature (storm, heavy rains), traffic (running train, trucks), people (strangers, barking dog) and events (fire work, jet coasters, top of the building etc) (Table1). And for relieving their heart-beats occurred by the stimuli, we inserted scenes of nature and their nurseries' faces in between the stimulus movies.

Facial emotion simulations

For facial emotion simulations, we prepared slide images showing five basic emotional expressions on unfamiliar faces of adults (surprise, anger, happiness, fear, sorrow: *Unmasking the face by Paul Ekman*1987) (Fig.2). Each facial emotion was played by 4 people (each two female and male professionals) for 17 seconds.

Table1. Categories of simulated events movies

	Nature	Storm, wind, heavy rain
	People	Barking dog, strangers
	Traffic	Truck, train, motorbike
	Events	Fire work, jet coaster

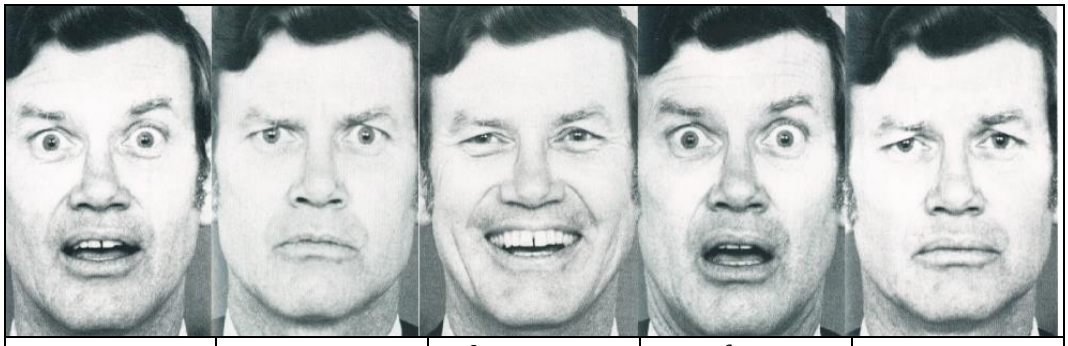


Figure2. Facial Emotion (Unmasking the face, Ekman 1987)

2.3. Heart rate measuring

During the experiments, we recorded subjects' heart-rates with Electrocardiogram (ECG). We measured it to check physiological change and we observed children's behavior during the experiment. Experiment was taken for 15 minutes in total. Instantaneous heart-rate was obtained from the ECG to calculate the change in heart-rate. The electric bandage was obtained extra soft disposable ones not to be harmful for children's skin. For children' safety during the experiment, the study plan was reviewed by Committee of Ethics on Research program of University of Tsukuba 2007, 2009.

3. Results

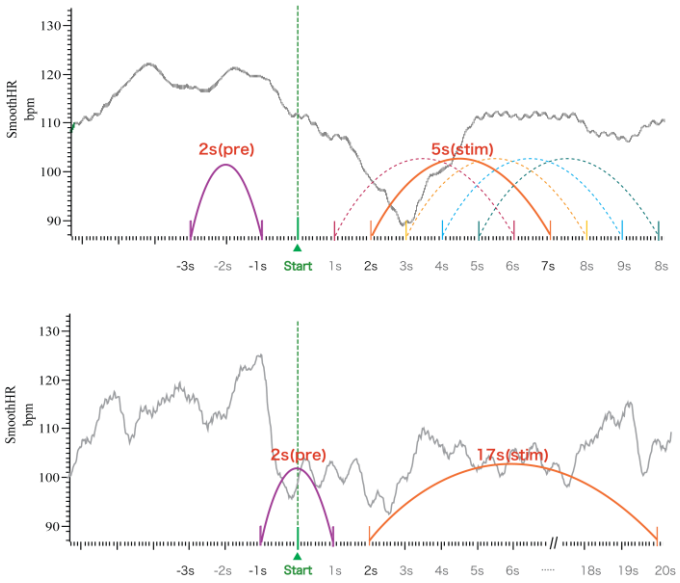
3.1. ECG results

The heart-rates response to the movies was different between the age groups. We divided the 15 subjects into three groups, one for 1~2 year, one for 3~4 year and the other for 5~6 year-old. Each group has 5 children. While the 1~2 year-old subjects mainly showed decreases or no changes in heart rate for almost stimuli, and the 3~4 year-old exhibited clear changes of reaction for each stimulus as we expected. One of the subjects in 1~2 year notable exception appeared to the response to movies of their nursery school teachers; children of all age groups tended to show decreases in heart-rate for teachers. An age-related difference was observed also for the response to emotional expressions. Elderly children were more likely to show clear changes in heart rate than younger children for each emotion. Thus, for both movies and facial images, elderly children tended to show a wider range of responses between subjects. Interestingly, their behavioral responses during the experiment showed an opposite tendency. When the images turned to negative emotions, such as sorrow or anger, younger children often covered their eyes with their hands or turned around their faces to their parents while most of elder children kept watching the given visual stimuli. Elderly children better accustomed to how to react to those emotion.

3.2. Analysis

Simulated Events movies

The data of ECG should be prepared by state of average of before the stimuli (Pre.) and state of average of during stimuli (Stimulus). We analyzed the data as change of heart rates come from the gap of each average (Stim.-Pre.). For Simulated events, three seconds before the stimulus (Pre.) adapted and the average of stimulus was for 5 seconds, 2 seconds after the stimulus until 7 seconds.



Facial Emotion images

Between the stimulus images, it has fade-in and out effects to change the slides, we had to calculate 2 seconds of (Pre.) condition when the stimulus starts to show up (1sec) and after shown up (1sec). For the average of time viewing the images, 17 seconds was calculated in facial emotion stimuli (Fig.3).

We constructed an interface to overview the children's faces, ECG data and stimuli at the same time (Fig.4) to analyze the data easily.

Figure 3. Stimulated Events (upper) and Facial Emotion (lower), gap of averages

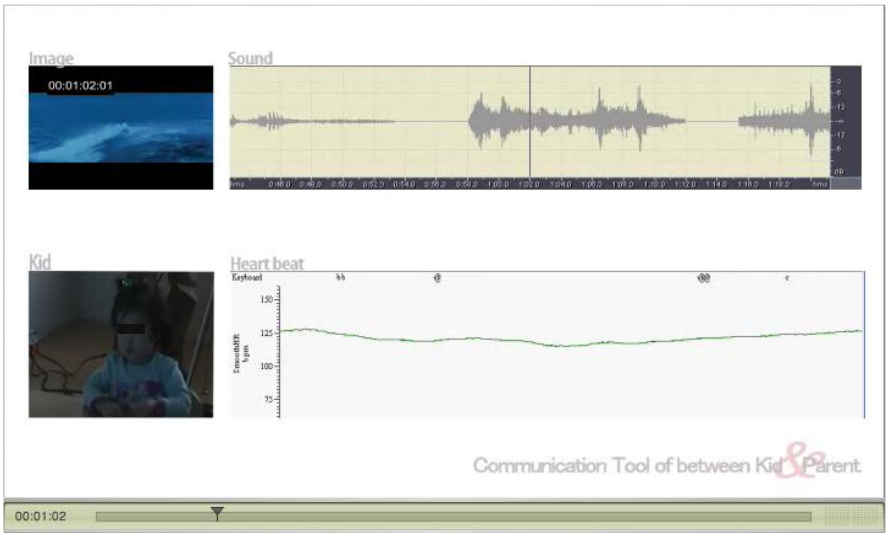
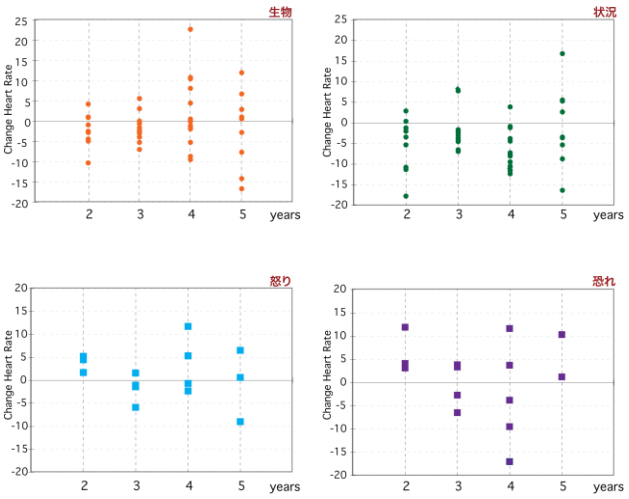


Figure 4 Interface combining stimuli, subjects and heart rates



Stranger (up left)

Events (up right)

Anger (below left)

Fear (below right)

Figure 5 Different heart rates depending on children's ages.

4. Development of the wearable device

The concept of device named "Omusbi [4]" means a rice ball which mothers make for their children in Japan. The name of device hopes to connect children, parents and people in the local network to help children's safety. The final device is now developed as an experimental prototype for children to know how long they can keep wearing the device (weight), how gentle they use the device (treatment), and which color or designs would be selected by them.

The positioning of heart-rate bandage on the chest was also tested before we set up the device. We tested every point near the heart where can get the clearer signals (Fig.6). To attach the heart-rate sensors, it should be needed at least 50mm separated space between two spots.

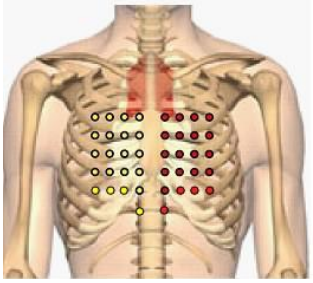


Fig.6 Hear rate Positioning

Finally, in the device the heart-rates, movements, and voice recorder, camera with with fisheye lens is adopted and all the sensors are controlled by micro computer to store and send the data. It is also under going to obtain technical patent copy rights.

5. Conclusion

This study revealed that, for both simulated movies and facial emotion, each age group exhibited different responses in heart-rates and behavior at the same time. The age-related changes in physiological and behavioral responses of children probably reflect the amount and variety of experiences that they have been acquired. The results suggest that the heart rates could be a useful tool to detect anxiety of children who cannot verbally express their feelings to the parents. We conclude that applying the sensors not only heart-rates but also behavioral movements (3D accelerator) would be easier to know children's conditions in danger. For the final step to build the device more efficiently, this result would be the first step to confirm how children react by physiological responses.

6. Acknowledgement

This is a research to develop a wearable device for kids' safety. Our goal to develop a wearable device is a contracted project with SCOPE (Strategic Information and Communications R&D Promotion Program), Ministry of Internal Affairs and Communications, JAPAN

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