Gaming to Sit Safe: The Restricted Body as an Integral Part of Gameplay

Petra Sundström[1,2,*], Axel Baumgartner[2], Elke Beck[2], Christine Döttlinger[2], Martin Murer[2], Ivana Randelshofer[2], David Wilfinger[2], Alexander Meschtscherjakov[2], Manfred Tscheligi[2]

[1]Mobile Life @ SICS
Kista, Sweden
petra@sics.se
*work conducted during a postdoc stay in Salzburg

[2]Contextual Interface Laboratory, ICT&S Center
Salzburg University, Austria
firstname.lastname@sbg.ac.at

ABSTRACT

This paper presents a design exploration of full-body interaction games played in cars. It describes how we have designed, implemented, and evaluated the core experiences of three different games, which were all aimed at making sitting properly more fun for players/children while travelling by car. By making the restricted body an integral part of gameplay, we hope to, as a side product of gameplay, bring about the best and also most safe body posture for young players/children travelling by car, i.e., sitting reasonably upright and still in their child seat with their head leaning back on the neck rest. Another outcome of this could also be an overall safer situation in the car, in that children not sitting still in their child seats while being driven might be stressful for the driver. By presenting the details of our design efforts in this particular design context, we hope to add also to the knowledge we, in HCI, have for how to design bodily experiences with technology at large.

Author Keywords

Restricted; Still; Calm; Bodily; Core; Experiences; Automotive; Gameplay; Explorative; Grounded; Design

ACM Classification Keywords

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

INTRODUCTION

The car is a common place to be that offers unique opportunities for design. Travelling by car can be relaxing, fun, awkward, interesting, even thrilling. The car is like a private and sometimes shared "bubble", travelling next to other such private and shared "bubbles" in an often-changing environment. This has been noted by, e.g., Katz [17] and later Juhlin [16] but since then, sadly few. Interactive systems within, or in the vicinity of, this context hold the potential of making use of all the contextual factors of being in the car, the car itself, the traffic situation, as well as the social and physical surrounding environment – a stage for a range of novel, useful and interesting designs for user(s) to engage with, and/or make use of.

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Still, there are not enough innovative and experiential designs making use of this potential. There is a range of systems focusing on the driver and the obvious safety precautions that need to be considered when driving a car in traffic, systems often subsumed under the label ADAS (Advanced Driver Assistance Systems), such as: adaptive cruise control, blind spot detection, or automotive night vision. There are, however, much fewer systems like McVeigh-Schultz's et al. [19] system, making more playful use of the in-car sensor data; in this case, for a life logging system that engages drivers in ongoing discoveries concerning their vehicle, the driving environment, and the social context throughout the lifecycle of their car. And as, Meschtscherjakov et al. [20] and Perterer et al. [23] have noted, there are also other areas and personas in this context to be designed for other than the driver. Of course it is important that no system disturbs the driver, but not everything in the car needs to be designed explicitly for the driver to use.

In this direction, Brunnberg et al., some years ago, talked of the *backseat playground* [4]. While Brunnberg et al. aimed at making the journey of the, often young, passengers travelling in the backseat of cars more enjoyable through playing a set of interactive games, our aim has been to take this idea one step further. This, by explicitly directing focus on the young passengers, restricted body posture in this context. The safest position for young passengers in the backseat is to sit upright and still with the head preferably resting on the neck rest. Our goal has been to see if we can design game(s) using the restricted body as an integral part of interaction. This to make it more enjoyable for young passengers (3-8) to sit safely when travelling by car; and, in doing so, also potentially act to reinforce safety for the other persons in the car, where the driver is the most significant other such person.

In this paper, we report on how we have taken a Research-through-Design approach [31] and explored this idea in three different ways. We designed three games that make use of the restricted body and various aspects of driving using three different sets of digital materials. What we more precisely have done is used a grounded explorative design approach to arrive at a deeper understanding of what we see as an interesting *design space* [28]. From such activity it is all the methods and techniques used that will help another designer when approaching that same design space and/or aiming for that same imagined experience. We therefore report carefully in this paper on how we have used a technique not so often seen in HCI and IxD, but rather more often so in game design that is designing for and evaluating the *core experience* [25] of a game before heading into system complexity.

Our aim with this paper is thereby twofold: first, to show the potential of an interesting and underexplored design space, and second, in doing so also argue for more of grounded experience-centered explorative work procedures within HCI and IxD.

Here follows a short description of the three games that were designed and built. First, *RainbowBalance*, a game where we focus on balance and play with small forces anything in the car is exposed to while the car is in motion. Second, *emoCar*, a game where the car itself is said to be emotional based on how it is driven and where we play with small but expressive facial expressions. Lastly, *GhostCatcher*, a game that in contrast to the other two does not use an ordinary screen display but instead a jar that expresses through vibration and sound how many ghosts it holds, where we aim at a sensation of suspense to encourage the children to hold a 'frozen' posture.

In the following, we will, in more detail, discuss the incentives for designing these games and the work procedure we have aimed for and also followed. We describe how we have developed the core experiences of the three games to the level where we together with the children could experience them in situ and thereafter all together discuss them and the children's experiences with them. With this paper, we want to inform and inspire other researchers and practitioners to also develop for this inspiring design space that holds so much potential for novel, interesting, experiential and useful design. More specifically, the descriptions we provide should help anyone wanting to go further than we have for designing more product-like game(s) aiming for making it more fun for young child to sit properly and thereby potentially more safe while being transported by car.

BACKGROUND

In 2009, the NHTS (National Household Travel Survey) found that American children, aged 5-15, spend on average 39.29 minutes per day traveling in a privately owned vehicle [21]. From McDonald's [18] studies of the travelling patterns of American children up to the age of 18, we can also see how auto traveling is the most common means of travel for these young citizens, and how it peaks when they are 3-5 years old. Therefore, it is slightly surprising how researchers and industry primarily have been focusing on the driver whilst mostly neglecting the passenger areas in cars [20], and especially those areas that often seat these young frequent passengers.

In Austria (the country where this project was set up), children up to a size of 150 centimeters tall must be seated in an appropriate child seat (like in most other countries). For a child aged 3-8, this means a forward-facing child seat positioned in the back. To reduce injuries in the case of an accident, the child is supposed to sit upright, still and with his/her head rested against the neck rest, a position that also is good for preventing accidents of carsickness. A child traveling by car also needs to be relatively quiet as to not disturb the driver, who needs to concentrate on the primary task of driving [11]. Most of us know, or understand, though how all this is hard for some child to accomplish, especially during long periods of time. Our idea is therefore that we perhaps can support this restricted body posture by making it an integral part of gameplay.

In general, there are a lot of games that children play where staying still or holding a frozen posture is played with. In the English speaking world, there is for example a game called *Stop dance,* where children dance to music that is suddenly stopped and the children then need to freeze in order to stay in the game. This game exists in many other countries as well. In HCI, a similar playful approach to staying still can be found for example in the growing bulk of games using brainwave interaction, where Brainball [12] very much paved the way. Similarly, there are also games using gaze-based interaction [e.g., 8] and breathing [e.g., 28], where not moving can be *a means to an end*, however not something explicitly designed for. Moreover, there are games and systems where the users/participants remain still but are moved around, such as in a roller coaster ride. Additionally, within HCI there has recently been a small but significant strand of research focusing on slow, sensual, somaesthetic experiences with technology [e.g., 26]. The work we present here is also related to the range of commercial systems for practicing meditation and yoga (e.g., Wii Fit Plus).

Trying to stay completely still (i.e., trying to hold a frozen posture) is however almost impossible, and in the long run also not enjoyable. If all muscles are not in a relaxed state most of us will soon start to shake a little. After some time, it will start to hurt. In a completely relaxed state, it is likewise difficult not to move at some point, as our internal organs will be moving and we also need to breath. The fact that it is difficult might be one reason though for why both grown-ups and children in various games and exercises enjoy the challenge in trying, and even admire if someone else can do it, as seen in, e.g., street acts dedicated to so-called "living statues" (http://www.worldstatues.nl). Partly it is about body control, and for a child, body control is especially difficult. At the same time, body image and body control are important prerequisites for the learning of concepts and skills, which is why it is a good thing for young children to practice for example various static balancing acts [5].

The games we present in this paper are not directly based on any established exercises for achieving better body control, nor are they designed to have the children sit completely still, as in holding a 'frozen' body posture. The games presented in this paper are to be seen as games using body control as a game trigger where very small, slow, controlled movements are played with. We have wanted for the children we have been working with to understand how they need to use some aspect of stillness to interact with the games we have designed. And then, when mastering this a little our hope has been that they would move forward with also appreciating and exploring the bodily sensations of this restricted, subtle, slow-moving interaction model.

While we in no way aim to criticize serious gaming, we find it critical to state that our aim never has been to educate children in the reasons for sitting still while in a moving car (not saying this is not important). Neither has our aim been to change any longer lasting behavior of the children we have been working with. The aim has been to design for engaging bodily experiences where small amounts of movement and a safe sitting position are made an integral part of gameplay.

Designing for any bodily experience with technology is however notably difficult [e.g., 9,14,27] and perhaps even more so when that is a slow interaction. In the following section, we therefore describe how we see design in this context more as an explorative journey in a design space, rather than a structured, however iterative, procedural set-up starting with a well-defined problem and ending in what is then considered the best solution for that problem.

DESIGN AS A JOURNEY IN A DESIGN SPACE

A design space is a *"multi-dimensional space containing an endless amount of solutions"* [28, p. 1]: in such space it is a concept, an imagined experience, or the idea of something, rather than a problem that directs the design process. The notion of a problem hints at a way of thinking where there exists one best solution to a given problem, a solution that is measurable. In a design space, there is an endless amount of solutions or designs that could allow for imagined experiences or conceptual ideas. Thinking of design as a space of imagined solutions moves us closer to a rich landscape of possibilities where there is not one optimal solution, but many possible designs. Gaver and Martin talk of these specific designs as placeholders *"occupying points in the design space without necessarily being the best devices to populate it"* [10, p. 216]. With that, it is somewhat sad that we see so many papers in HCI and IxD that present only one system thought to embody the researchers thinking and ideas for design.

We want to see more of sincere design explorations, where a high-level idea is explored from what different scenarios and experiences it might hold and from how those experiences feel when being actually designed for, i.e., implemented to the level where they can be tested and felt. Far too often, an explorative approach is applied only in the early phases of design when working almost exclusively in various low-fi materials [5], and then when heading into phases of implementation we in HCI and IxD tend to use more of an iterative approach focusing on only one of the initial designs. This is problematic, as we in low-fi cannot tell how an idea will turn out and feel when being actually implemented for [9]. As researchers especially we should more often take the time to work in parallel on a few possible systems embodying our ideas for design -- as multiple alternatives also create higher quality work [7].

Moreover, a design space can never be fully described due to its complexity and size. There will never be just one defined way to follow to a successful design, as there can be many such designs. Westerlund [28] describes how a shared concept or imagined experience can act as a *conceptual tool* to direct a design team within a design space, to help them choose between what methods to use, and between various alternatives for design. In turn, all the different methods and techniques used during the design process, will help another designer or team when approaching that same design space aiming for that same imagined experience, but set up in a different way, or in another contextual setup.

With that in mind, and given that digitals are so complicated for many designers to work with [23], we want to direct attention to how we for the work described in here have borrowed from game design the idea of first staging the core experience of a game, before taking the next step into more system complexity. In game design it is a well-known fact that the whole game might fail if the core experience, and the pure feel of the game, is not carefully designed for in the final design. As practicing design researchers, we have also seen this when working in various designs aiming for taking into account the experiential aspects of communication. For instance, when finding how a misplaced, slow-to-connect Bluetooth connection ruined the emotional engagement, we oftentimes managed to build up the interactive trajectory we had users engage in [9]. Especially when designing for bodily experiences that are so sensitive to failures like that [27], we should start with making sure we can implement the core experience of a system before heading into more of system complexity. Probably we should also take the time to evaluate that core experience before doing so.

To demonstrate our ideas, we have designed, implemented, and evaluated three core experiences of games that make it fun for a young child to sit still while being transported by car.

THREE GAMES

For each of the games, we wanted to either use the car itself, an aspect of driving, or both as a *design trigger* for our imagination. In addition, we wanted each of the games to make use of the restricted body in a different way from the other two. This is to cover more areas and, thereby, come to understand more of the design space we set out to explore. A high level goal was also to see if we could have the children become more involved in the activity of driving when playing the games and allow for more of a shared game experience among all the passengers in the car.

For clarity, each game description starts with a description of the game in its final state. Note though, that the three games were not thought of, designed, and implemented following a step-by-step procedure, which this presentation style might falsely give an impression of.

RainbowBalance

RainbowBalance is a game where we focus on balance and where we play with the forces everything in the car is exposed to while driving. In this game the goal is to balance a virtual ball that changes color over time. If skilled, a child can collect the colors of a full rainbow and acquire a treasure at the end of that rainbow, see Figure 1a for the interface design.

This game idea started from how we remembered how it was fun when children to lean in with the forces the car is exposed to when driving through a curve. How it was fun to lean with those forces, even exaggerate the effect of them, rather than staying in the child seat. Some of us have also seen our own children do this. We, therefore, wanted to see if we instead could make it fun for a child to try to fight these forces, and by that stay where they should be in their child seat.

We got the idea that a balancing-act might have the children stretch a little and sit more upright and still. We first explored this idea using a traditional tennis ball that we ourselves tried to balance while taking turns being transported by car. This (of course) turned out to be way too difficult and we quickly understood how this balancing-act would be more of a fine-tuning task finding the right level of difficulty, rather than being a difficult task in setting up a system for it.

We, thereby, rather quickly implemented a system where children virtually can balance something like a ball on their heads and where they can see the consequences of this on a screen in front of them, which is attached to the back of the front seat passenger seat. To make it slightly easier than when playing with the tennis ball we decided to place the virtual ball in something like a bowl pretending for this bowl to be moving perfectly in line with the movements of the head. It was furthermore decided that we were to place both items on an avatar head rather than on an augmented camera image of the player him/herself. This to reduce the visibility of tracking issues. The ball was to be affected by the movements of the car, tracked by an accelerometer on the floor, or if possible, calculated from the movements of the head in relation to gravity. For tracking the movements of the head, we first thought of attaching a Kinect camera to the roof of the car.

Experimenting with the Kinect for a while, we found how it was not possible for us to separate a child's head from the neck rest given the little distance between these two in a normal five-seated car. Working in parallel with emoCar (described next) we instead found the solution in the Fraunhofer emotional recognition system[1]. This system analyzes live video from a webcam to extract information about facial emotional expressions. It also provides the position of certain facial features, such as the eyes, nose and mouth. From the position of the eyes, relative to ground, we got the angle of the head.

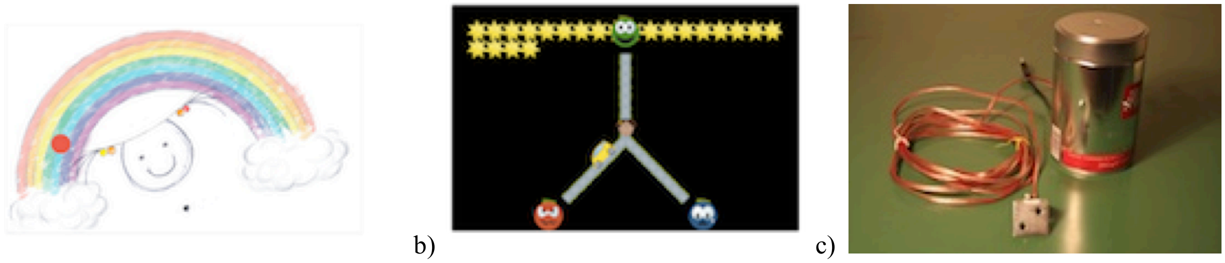
As to calculate the movements of the ball (how it was affected by the movements of the car) from sideways movements of the head in relation to the center of the child seat, it turned out that the head movements induced by the car's forces were not quite enough for this purpose. In contrast the solution of having an accelerometer attached to the car turned out to allow for a highly fine-tuned experience, if wanted.

Then again, what we aimed for were core experiences that could be tested and felt, which is why the graphical interaction design was kept to a minimum. To make it a game experience that could be played for a while though, we found it an easy but reasonably good solution to have the ball change color over time. Making it possible for a child to collect a full "rainbow" of colors and that way get hold of the treasure at the end of the rainbow. We are aware that core experiences in game design more often refer to the core experiences of an already thought of more complex game. Here we used the technique to evaluate a set of potential experiences that in some different way from the other two experiences explored, make use of, the restricted body in an interaction staged in some mini-game. And again, staging for core experiences, that at a later point in time if showing to be successful, can be used as part of a more complex fully-fledged game scenario, either one of them or all three combined and used at different times in a storyline trajectory [1].

emoCar

Our second game, emoCar, is a game where the car itself is imagined to respond emotionally dependent on how it is driven, i.e., angrier if driven unsmoothly, happier when accelerating, and more sad when nothing happens, such as when standing still in front of a traffic light. In this game, driving style affects the direction of a small car avatar, driving on the roads between happiness, anger, and sadness (see Figure 1b). The goal for the child is to "catch" this car

[1] http://www.iis.fraunhofer.de/EN/bf/bv/kognitiv/biom/dd.jsp



a) b) c)

Figure 1. The interfaces of a) RainbowBalance b) emoCar and c) GhostCatcher

avatar (i.e., come on top of it with his/her own avatar) by performing the appropriate facial expression for the direction the child thinks the car avatar will go.

With this game, we wanted to direct focus to the small but highly expressive muscles of the face. The idea was to use the fact that systems for emotional face recognition work better if the head is held still and in the correct position in front of the camera in use. This way we wanted to reinforce "good" behavior by having the children notice that interaction works better if they keep their head in the right position, i.e., high enough and straight in front of the camera in use. An activity that in turn would have them sit more upright and still, but so only, if the game experience made them want to do so, i.e., if it was engaging enough.

We, therefore, brainstormed for ideas on how to connect such interaction to driving in interesting ways. The idea we found most intriguing was the idea of the car becoming emotional from how it was driven and how such connection potentially would allow for more of a shared game experience between the child and the driver, having the child potentially comment on how the car was driven. Also, we were intrigued by how this idea holds promise for affective loop experiences [13] using the same emotional cues in both input and output that build for emotional responses over time. Yet another intriguing reason for this idea was how it potentially would have the children, in order to acquire more points, rotate the avatar car by quickly alternating between two emotions on different sides of it. An activity we thought would be bodily very entertaining even though it just involved the small muscles of the face (please try it for yourself).

Having previous experience within the design team of working with the Fraunhofer emotional recognition system [e.g.22], we knew how some emotions are easier to track than others. For this specific engine, these are happiness, anger and also surprise; but here we thought sadness was a better alternative to surprise for us to use as it is an emotion more in opposition to happiness and anger, i.e., more activity for the face muscles; and sadness is most likely also easier for children to express and connect to how the car was driven.

Our task was then to find a way to calculate those emotions from car data in a way that was to make sense to children playing this game. Being intrigued by the potentials of the Kiwi Bluetooth dongle from PLX Devices[2], we saw the potential of exploring various algorithms for detecting "aggressive", "fun" and "boring" driving, activities we could connect to anger, happiness and sadness, i.e., the possible emotional states we had set for the car. This dongle allows for real time data acquisition from the car onboard diagnostics port, in the form of, e.g., acceleration, rounds per minute, and runtime from start. We ended up exploring two different algorithms where in fact the simpler of the two turned out to work surprisingly well for our purposes. This algorithm basically takes acceleration, and if being a positive value it makes the car happier (inferring how it is fun to speed up), if being a negative value it makes the car more angry (inferring a lot of breaking and hard driving, a driving style that can make anyone angry) and if being zero it makes the car more sad (inferring how it is boring when nothing happens). The other algorithm we explored was an algorithm based on an ecological driving style, but this algorithm turned out to be much more difficult for both us and our test participants (i.e., various children) to relate to the actual movements of the car.

The Fraunhofer emotional recognition system then turned out to be very sensitive to the varying lighting conditions in the car, which caused some difficulties when creating emoCar. When the weather was cloudy, the lighting in the car was perfect for emoCar, whereas when it was sunny, shadows would run over the children's faces and produce data with too high variability. Thus, we worked on finding a technical solution where data was buffered and preprocessed to create stable output in all weather conditions, however then losing some of the fine-tuning of the game. Further, we found how it was more difficult to track the faces of the children than the faces of grownups. We assume that this system is assembled from the faces of grownups and believe that there still are (if any) very few such systems that sufficiently work with the faces of children.

GhostCatcher

Our last game, GhostCatcher, is a game that, in contrast to the other two, does not use an ordinary screen display. Instead, this game consists of a jar, see Figure 1c, that expresses through vibration and sound how many ghosts it

[2] http://plxdevices.com/

holds. The challenge for the child is to open the jar just when the car is exposed to darkness, e.g., when driving into a shadow or a tunnel. By opening the jar in darkness, the child captures the ghosts into the jar that then starts to vibrate and make various sounds. As long as there is darkness the child can hold the jar open and capture more ghosts (the vibration and sounds continue). If the child does not manage to close the jar before lightness takes place, i.e., before driving out of the shadow or the tunnel, all ghosts will run away and the jar will go silent and still.

From our early user tests with RainbowBalance and emoCar, we noted how the screen display easily absorbed the children so that they forgot about what was happening in and outside the car. As we believe it maybe considered beneficial for children to look also outside the car and/or interact with the other persons in the car we wanted for our third game not to hold a screen display but rather be something that made use of lighting or sound as output modality. Moreover, we noted from our work on RainbowBalance and emoCar how the children had a hard time doing nothing with their hands, and how they when playing emoCar especially had a hard time keeping their hands away from their face and thereby interfering with the camera in use. We thereby decided for the third game to be something where the children were to occupy their hands by holding onto something, or a system where they would do something little with their hands.

Our first idea in the direction of gesturing and no screen display was to build a system where the children were encouraged to capture the rhythm, during nighttime, that is created by passing traffic lights. We remembered this being an activity we ourselves had engaged in as children. We sought inspiration by playing various rhythmic games with children. We also built a first working prototype tracking lighting and darkness in a way that aimed for making it possible for us to develop this idea further from experience, both from our own experiences, as well as from the experiences of a few children. Realizing how we had to stay up very late to test this prototype in situ and how also the time of the year (springtime) meant that darkness was going to take place later and later in the evening, we came to see how we had to rethink. Depending on when children go to sleep, they may not even see dusk during this time of the year. This might sound like a bad reason for not going forward with an idea, but as a matter of fact, these types of circumstances very much set the stage for emerging programming practices as of today [15].

When playing around with the prototype we built to experience this idea, we found that it perfectly well detected the shadows the car was exposed to from houses and other moving and stationary objects while driving around in the city center of Salzburg, Austria. This made us think about darkness, and how a “fun”/joyful experience can be also a slightly scary and/or thrilling experience [1]. We came to the idea of a ghost catcher where a child can be told that there are ghosts to be caught when in darkness, but how those ghosts might run away if the child does not close the “catcher” before it gets light again. This setup was then implemented using a small coffee jar in combination with two light sensors tracking if the lid is open or closed and if the car is in darkness. When a ghost is caught and forced to remain in the jar, it starts clamoring and the jar starts to vibrate, or increases its vibration if there were ghosts there already. When ghosts escape they giggle and the jar stops vibrating. Also, there are differences in sounds and vibration patterns to convey how there can be different kinds of ghosts, e.g., what was later experienced as cat and snake ghosts by some of the children.

The initial ideas for these games came up in various brainstorming sessions and while thinking about the task and the design space in general. What is special for this project is that we as early as possible tried to implement a first prototype of the technical underpinnings of an idea before deciding too much on the details of it. We also did this even where we sometimes disagreed on the potentials of an idea. Our aim was to as far as possible take decision based on experience, our own, as well as the experiences of potential users, and preferably in situ. Also, we wanted to avoid taking an idea conceptually too far before looking into technical possibilities and issues of implementation, as we from experience know technicalities can be totally decisive for an IxD idea. Some ideas that were implemented for were in the process dismissed. This was a very intentional shared decision we took setting out to do this project; to consider all these first prototypes as they were, very simple versions of an idea we have had, and not as systems that already had been taken so far that the idea therefore had to be followed through with. We believe this allowed for a better-shared design process for a set of designs grounded in what users do and suggest, but also in design and in what the design material in HCI and IxD, i.e., digitals, affords.

A COMPARATIVE EVALUATION

Children, the potential users, were as stated several times already involved in the making of all three games, and some of them had even told us their favorite among them. But to understand better what these games can tell us as designers and researchers about how to design for the restricted or restricted body, and how the games we have designed possibly at some point can be used to make safe seating more fun, we ran a more evaluation-like test in May 2012 of all three of them played consecutively by a group of young children.

Setup & Procedure

For the evaluation, we prepared a car with all three games and equipment for documenting the experiences of eight children age 3-8 (four boys and four girls) each playing our three games for approximating one hour total one after the other. It needs to be stated how it nonetheless was far from an un-complicated task involving children this way in the project due to the security precautions that by necessity need to be taken when equipping a car with new, unfinished technology driving in real life traffic. In the process of developing the games, we for this reason mostly worked with our own children and their friends as we found it easier for us as project members (and concerned parents) to understand that the technology was carefully secured and, therefore, did not add any extra danger to the children other than normal when in traffic. For this reason, all children assigned for this study were selected from the friends of the children of the first author who also drove the car this day, something we believe further helped to gain the trust from the parents involved. For one child the experience took place on the streets of Salzburg, but for the other seven we drove up and down the hills near Schladming (a ski resort close to Salzburg). We were one driver and another researcher together with the playing child in the car. Parents were offered the front-seat passenger seat if they or their child wanted that. Four children were this way accompanied by an older sibling or a parent. Parents were also offered the option to drive the car if they felt insecure about us driving, but no parent chose to do so.

In random order, each child got each game explained to him/her and was then allowed to play the game for approximately 10 minutes before it was time for the next game or the concluding questions. The backseat area and the road in front of the car were videotaped, helping us to afterwards analyze the children's interactions with the games in relation to their verbal and non-verbal expressions during gameplay. Right after having played all three games and while still in the car we used what is called the laddering technique. This is a technique that has turned out to be successful when working with young children especially [30]. It is a technique where one poses higher-level questions followed by why-questions until there seem to be no more answers to give. For our purposes, we worked on two ladders with the children: *"Which game did you like the most?"* followed by why-questions, and *"Which game did you not like so much?"* followed by another set of why-questions. We did not ask the children whether or not they found it more fun to sit still playing the games we had designed as we do not believe such a direct question would have been appropriate with such young children, who to some extent thought everything this day was highly exciting. Instead we later used our video documentation to infer the children's interest in playing the games by detecting their verbal and non-verbal expressions during gameplay. For example, we looked at expressions such as the children's direction of gaze during gameplay linked to game activity. If they, for example, were looking away from the screen without appearing to be looking out for a curve or a traffic light that would matter for their gameplay, we interpreted this as a sign of the child losing interest. They looking steadily on the screen as used for RainbowBalance and emoCar, or looking out for something that would matter for gameplay, was interpreted as the child being deeply concentrated with the game (in relation to verbal things they said). Likewise, a steady position of the children's hands on the jar and the lid as used for GhostCatcher was interpreted as a sign of being prepared for game action, thus a sign of interest. Facial signs for happiness like a smiling mouth or laughter when not performed during gameplay were interpreted as positive signs for the children finding the games fun to play.

We are aware that observing non-verbal communication like this does not let us infer the source of interest, which in reality can be anything. Therefore, we also interpreted our observations in combination with the children's answers in the laddering sessions, where they pointed out the reasons for why they liked or disliked something specifically. And even though we feel slightly hesitant about us achieving proper ladders with the children we believe the laddering technique helped us initiate fruitful discussions with the young children we were working with. Two ladders were a maximum, as the children when not getting to play anymore mostly wanted to leave the car to instead play with their friends.

Findings related to preferences and gameplay

GhostCatcher was experienced among all children as the game they liked the most (except one who refused to choose). This was regardless of the fact only three of the children had weather conditions that produced proper shadows. For the rest of the children, there were stationary objects such as the bus station where there were roofs covering the various bus stops that we intentionally drove under when these children were playing this game. Having identified GhostCatcher as their preferred game in the laddering sessions is in line with our observations of the children's non-verbal communication behavior. Nearly all the children kept both hands on the jar, being ready to open it at an appropriate moment, and half of the children smiled or laughed when they, for example, opened and closed the jar and caught a ghost, or when a ghost accidently escaped them. It was the interaction modality and the topic of the game – catching ghosts with a jar – that made this game fun as pointed to by all of them in the laddering sessions.

There was no one game our eight children did not like, even though most of them had problems either with RainbowBalance and/or emoCar. RainbowBalance had worked perfectly fine during our test-drives in Salzburg, but in Skiing Resort Y where the traffic situation is completely different, we noted how this game got too easy to play. We could see this from how some children lost attention after a while, though some in their laddering session said they liked the fact that it was easy to play. However, funny moments did occur when RainbowBalance was experienced as challenging: six out of eight children laughed each time the ball fell off the head of the avatar, or when it was close to falling off (both signs of not completely mastering the game). RainbowBalance was furthermore not really

Figure 2. From left to right; a) Player coming to understand the small movements needed in RainbowBalance. b) One player tries to express anger in emoCar also by clenching his fists. c) One of our three-year olds playing GhostCatcher preparing himself by looking out for darkness ahead of the car.

appreciated in terms of being the engaging game experience the children felt was offered by GhostCatcher.

emoCar on the other hand was from time to time (depending on what emotion the avatar car was heading towards) experienced as too challenging. Especially anger and sadness were emotions difficult for the children to express in a way that the system understood them. But there were also funny moments occurring when playing emoCar. Three children showed facial expressions of happiness, which were then not used for controlling the game. Interesting was how sad and angry faces seemed to be especially fun for the children to express even though the system not always could interpret them. Funny was how they then laughed, something that then interfered with gameplay, something that then had them laugh even more, i.e., successful affective loop experiences [13].

Findings related to an engaging and safe body posture

Additionally, we used the video documentation to look at whether the children sat in a safe position throughout gameplay. Here, we found how RainbowBalance holds a well working harmony between input and output. The children seemed to quickly understand from the movements of the avatar (the face with the bowl) what small movements they were supposed to use. Not all of them got it right away; some of them started out conducting too large movements with their upper body and thereby dropping the ball. As they continued playing, they all started mimicking the small movements as conducted by the avatar, see Figure 2a.

As regards emoCar, it did not provide enough support for how to make appropriate facial expressions. As discussed previously, most of the children had difficulties to perform especially the sad and angry faces as the system wanted those to be expressed. Thus this meant there was no tie into the issue as we initially had thought of -- that the children were to adapt to the system, stretching and placing their head better in front of the camera in use, as that would help them advance in the game. That part the children understood. The problem here was that the children basically used different emotional cues for the various emotions than those the system was looking for. And, at failure, instead of then changing expressions the children simply tried even harder to express the emotion in the way they thought it should be expressed. Many times the children then also involved other parts of their body in interaction, crossing their arms or clenching their fists, as in Figure 2b. Even though we understand how emoCar in order to support gameplay should be redesigned to encourage the emotional signs the system can read (as far as this is possible), we also see how this 'fight' with the system in a way made emoCar more fun to play, sometimes sliding away though from our aim of designing for calm, still bodily experiences. We believe nonetheless that we can design for such experiences involving some small movements. In the RainbowBalance game, for example, three children raised their hands just slightly to stop the ball from falling, something they did when they seemed to be most engaged in gameplay, carefully balancing the ball.

Findings related to automotive gameplay

In terms of being the fully intended game experience, the children connected to the movements of the car and to what was going on outside the car, GhostCatcher was our most successful game experience for this. Some children even made verbal statements that show to how they were able to do this, to connect the game to what the driver or to what the car was doing: *"There are ghosts in there, but unfortunately we can't go in there"*, *"Ah yeah, now I'll open it"* as a child said when the car was approaching a tunnel, or as when another child identified upcoming shadows and then shouted *"Here!"* What was further interesting was how even our two three-year olds could do this, how they started to keep track of brightness and darkness coming up ahead of the car while playing GhostCatcher (see Figure

2c). For RainbowBalance and emoCar, it could have been that the children understood the connection, but given the screen-display and the interaction happening there, it was harder for them to also keep track of what was happening around them, and plan ahead, as this also was for most of them their first encounter with the games. It could be that the connections in these games are too difficult for children 3-8 to make sense of or that they take longer to learn, but it cannot be said that children this age are not capable of planning ahead this way. That we could see from their interactions with GhostCatcher that they indeed were capable of; a setup they better understood and got more engaged with and for that reason perhaps more quickly wanted to learn more of and learn to master in order to advance in the game.

In summary, RainbowBalance offers an interesting interaction modality in terms of still, slow moving bodily experiences and mimicking. As used in RainbowBalance and together with the traffic situation in Schladming, this interaction modality was, however, not so challenging and did not come across as so exciting for the children to interact with. In turn, GhostCatcher that does not use a screen display, offers both what the children saw as the most interesting game experience and a game experience where the children were able to understand how it also connects to the car and to what happens outside the car. Something that had them sit both attuned and still, however perhaps not being so engaged with the bodily sensations of this stillness as with what was happening with the jar and/or ahead of the car. With emoCar we would not choose face recognition again, unless we could find a system that would work better with the faces of young children, and also not be so sensitive to the changes in the lighting conditions that will be happening when driving as we do not want to shade the windows. This is somewhat sad though as we so obviously could see the potential of designing for some truly engaging but small movement experiences with technology aiming for the small but so highly expressive and engaging muscles of the face. Extracting emotions from the behavior of the car, as in emoCar, we though strongly believe in, also from a technical point of view, as this worked well and was something that engaged both children and parents telling them about this connection when presenting the games and the study at large. It might take some time for a child to understand and be engaged with this connection though in the way we had hoped for. However, there is then the 'simple' matter of creating a more engaging game for it that the children will care more to learn as they cared for learning how to master GhostCatcher.

CONCLUSION

This paper describes how we approached what we see as an interesting, underexplored design space. It describes how we have designed, implemented, and evaluated the core experiences of three different games, all aimed at making sitting properly more fun for players/children while travelling by car. Our argument is that we by making the restricted body an integral part of gameplay, as a side product of gameplay, can bring about the best and also most safe body posture for young players/children travelling by car, i.e., sitting reasonably upright and still in their child seat with their head leaning back on the neck rest. And this way, through gameplay, make such safe position more fun to hold. This is however an argumentation we do not yet have full proofs for. Our hope is that we with the work presented in here both can inspire and provide guidance for anyone going about this design space and this task a second time. And by this arrive closer at some more fully-fledged game(s) that more extensively can be tested towards this goal/argumentation we believe holds great promise.

Certainly, a child traveling by car can be equipped with an iPad or potentially some video equipment to pass the time while travelling by car, but such equipment does not explicitly encourage a safe body posture, nor do such equipment make use of the full potential (if any) of all the interesting contextual data that is to be found in and around cars. Most importantly for this work is how such equipment does not direct attention to and, in gameplay, incorporate the more bodily sensations of the small movements that those other systems also make use of, and also do such equipment not explicitly encourage a safe body posture.

Furthermore, full body interaction games often refer to vivid, expressive experiences with technology. Not so much in opposition to more traditional joystick gaming, but as a way of emphasizing and making better use of the more bodily experiences of gaming. There are, however, very few interaction games that make use of and in gameplay incorporate the bodily experiences of moving very little. The question though is, can we make such experiences fun and interesting, and if so, how can we do that and what for? The work presented in this paper can in this direction moreover act as the basis for a range of services designed for more bodily aware, still interactions with technology. The restricted body and the safety precautions that by necessity need to be taken into account when designing for the context of the car have in this sense acted as a boundary box for a first design exploration of what such still bodily experiences potentially can be and how they can be designed for.

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