ABSTRACT
People using wheelchairs face barriers in their daily lives, many of which are created by people who surround them. Promoting positive attitudes towards persons with disabilities is an integral step in removing these barriers and improving their quality of life. In this context, persuasive games offer an opportunity of encouraging attitude change. We created a wheelchair-controlled persuasive game to study how embodied interaction can be applied to influence player attitudes over time. Our results show that the game intervention successfully raised awareness for challenges that people using wheelchairs face, and that embodied interaction is a more effective approach than traditional input in terms of retaining attitude change over time. Based on these findings, we provide design strategies for embodied interaction in persuasive games, and outline how our findings can be leveraged to help designers create effective persuasive experiences beyond games.

Author Keywords
Embodied Interaction; Persuasive Games; Attitude Change; Disability.

ACM Classification Keywords
K.8.0 [Personal Computing]: General - Games.

INTRODUCTION
People using wheelchairs face barriers in their lives, many of which are created by the people around them: research has shown that the general population holds negative attitudes toward people with disabilities, and that perceptions of disability influence how people with disabilities are treated [18]. This is a problem because able-bodied individuals often function as gatekeepers in settings that directly influence the quality of life, for instance, in education, employment, and leisure [24]. Disability awareness – empathy and a positive attitude regarding people with disabilities [39] – is an important step towards fostering positive attitudes and behaviour towards people with disabilities [18]. Various efforts have been made to help promote positive attitudes, such as the use of materials that help able-bodied individuals to better understand capabilities of people using wheelchairs (e.g., online videos [9]), or materials that let able-bodied people experience challenges that individuals with disabilities face (e.g., simulation exercises [15]). However, these approaches assume that able-bodied individuals have a volitional drive to understand people with disabilities; there is little logic in interventions for attitude change that require proactive participation because those who most need to change their attitude are also the least likely to participate. Game-based interventions can provide this missing motivation for participation, and persuasive games – games that are designed with the primary purpose of changing a user’s behavior or attitude – have been applied successfully in domains such as sustainability, international conflict resolution, and health (see persuasivengames.com). Therefore, persuasive games for attitude change toward people using wheelchairs are a promising intervention.

Although there are a number of persuasive strategies that can be employed to change attitudes or behaviours [12, 27] within a game, one of the most successful approaches in persuasive games is the use of simulation [29]. Game-based simulations allow the player to experience different perspectives, try out solutions to a problem, and observe the outcome of their choices on a time scale not possible in the real world. Traditionally, persuasive games focus the simulation in the game world, while interaction with the game is handled through conventional input devices. However, the concept of embodied interaction [10] in human-computer interaction suggests that interaction with the game could be made physical – incorporating the user’s own body and movements. Embodied interaction has been effective in interventions in other domains, such as learning [21] and health [36]. In the context of mobility disabilities, motion-based game control offers an interesting design opportunity: embodied interaction can be applied to allow players to physically experience challenges that persons using wheelchairs face, potentially strengthening the persuasive experience and resulting in improvements not only to awareness, but also to attitude. However, research in the field of disability simulation suggests that simulating
disability in able-bodied people may not be very effective and can lead more to frustration than understanding [13].

In this paper, we ask the question of whether persuasive games can be used to change attitudes towards people using wheelchairs. Furthermore, we ask whether the use of embodied simulation (i.e., simulation controlled through embodied interaction) strengthens the persuasiveness of the game intervention. To answer these questions, we developed a persuasive game that simulates common challenges in the use of wheelchairs. To study the impact of embodied simulation in games, we created two versions—one that is controlled directly with a wheelchair, and one that uses a traditional gamepad. We present results of a study with 40 participants exploring the effects of embodied interaction in our persuasive game. We assess participant attitudes one week prior to our intervention, immediately following gameplay, and after one week to explore attitudes over time, and we combine this information with player experience measures to further understand the effects of embodying interaction. Our results show that the game intervention successfully raised awareness for challenges that people using wheelchairs face, and that embodied interaction is a more effective approach in terms of sustaining attitude change over time.

RELATED WORK
We provide an overview of persuasive games. We show how embodied interaction can foster persuasion, and how embodied simulation relates to disability simulation.

Game-Based Persuasion and Attitude Change
Persuasive Technology aims to bring about desirable change by shaping and reinforcing behavior or attitude about an issue, action, or object [1, 12]. Various terms have been used to describe games designed for purposes other than entertainment, such as serious games (used to describe games that are designed to entertain, educate, and train players [37]) and persuasive games (used to describe video games that mount procedural rhetoric effectively [6]). Regardless of the terminology, these games focus on persuading players using various design strategies [9]. For the purpose of this paper, we define persuasive games as games that are designed with the primary purpose of changing a user’s behavior or attitude using persuasive strategies [12]. Persuasive games provide advantages over non-game interventions, including the motivation of participation [35], and the ability to trigger attitude change using indirect approaches by engaging users in play (e.g., by allowing for peripheral messages based on in-game conflicts rather than on an obvious rhetorical approach). Persuasive games have affected behaviour or attitude in a variety of domains, including smoking cessation [17], energy consumption [2], and healthy eating [3].

Persuasive Simulation Games
A number of persuasive strategies have been developed that can be applied to persuasive game design. For instance, Fogg [12] developed seven persuasive tools, and Oinas-Kukkonen [27] built on Fogg’s strategies to develop 28 persuasive system design principles, such as Customization or Self-Monitoring. Out of the strategies, Simulation is one of the prominent examples that can easily be transferred into games. It provides the means for a user to observe the cause-and-effect linkage of their behavior by encouraging users to observe and experience the world (or some aspect of it) in a simulated environment. It allows players to live and feel the world from another person’s perspective, and has been found to be an effective one-size-fits-all approach that is capable of motivating positive change in the majority of the players without demotivating others [28].

An example of a persuasive simulation game is Darfur is Dying [34], a web-based game that allows players to experience the difficulty of living among modern genocide and the hardship faced by Darfuran refugees with the aim of promoting attitude and behaviour change. Similarly, Sweatshop [8] is an online simulation game that allows players to experience the cause-and-effect of stakeholder actions in the textile industry to encourage actions that impact workers positively. These games are examples of how simulation games can be employed for attitude change by exposing the players to the experience of real-world scenarios during play. Hence, persuasive games employing simulation can also be considered for motivating positive attitude change towards persons with disabilities.

Disability Simulation
Disability simulation is an approach towards helping able-bodied persons experience life from the perspective of a person with a disability [15]; it relies on the embodiment of the disability to evoke empathy and a better understanding of disabilities. It is frequently applied in the context of mobility disabilities, e.g., disabilities that require the use of wheelchairs, where able-bodied persons are invited to exclusively use a wheelchair for a certain amount of time to experience challenges associated with wheelchair use [13].

While some studies claim that wheelchair simulations help improve attitudes towards persons with disabilities [15], others report that they do not provide an accurate experience (e.g., because blindfolding a sighted person will result in an entirely different experience than that of a person with a visual impairment), are overly challenging (e.g., because the able-bodied person is unfamiliar with the assistive device), and may ultimately lead to frustration [13]. A 2007 meta-analysis of disability simulation [11] reports only small positive effects of disability simulation, and underlines the importance of adequate challenges allowing able-bodied persons to cope with the situations that they experience in order to create effective simulations.

Game-Based Disability Simulation
Virtual environments have been applied to simulate the effects of different disabilities; Lewis et al. [19] build on a popular game engine to demonstrate the effects of visual
impairments, and in the context of simulating mobility disabilities, Pivik et al. [27] present a video game that invites able-bodied children to navigate a virtual environment that simulates the use of the wheelchair. The game is played using a mouse; results of a user study show higher awareness of barriers related to mobility disabilities, but no improvement of attitudes towards persons with disabilities. In this context, one problem related to game-based disability simulation could be the fact that they lack the physical dimension of disability simulations in the real world, and do not allow players to experience the effects of a mobility disability in a way that encourages them to be more empathetic towards people with disabilities.

Disability Simulation and Embodied Interaction
In our work, we leverage the effects of embodied interaction. Dourish [10] defines embodied interaction as a participatory process with a strong physical dimension; when individuals interact, meaning is given to that interaction through the embodiment of their interaction (e.g., the physicality of their bodies), and by the fact that it takes place in the context of the world. In Human-Computer Interaction, embodied interaction has been approached from the context of tangible interaction where real-world objects are integrated into interaction [16], and in motion-based interaction where users apply their body as input device [20]. In game development, video games with motion-based control schemes have been created to augment physical experiences (e.g., sports [25]) or engage broader audiences in play. Research results show that the physical aspect of embodied interaction – particularly perceived effort – can be exploited to shape the user experience [21]. Furthermore, results show that the inclusion of motor actions leads to an increase in the effectiveness of interventions in health persuasion [36], suggesting that embodied interaction can be applied to increase the effects of persuasive games.

By combining a simulation game with wheelchair input, players could experience the physical aspect of a mobility disability in a virtual environment, thereby maintaining the benefits of the embodied experience. However, using a virtual environment allows for a carefully crafted player experience with challenging, yet achievable game tasks that convey the core challenges of using a wheelchair while controlling the level of frustration among players. This approach could create a basis for further reflection upon the situation of persons using wheelchairs.

BIRTHDAY PARTY: AN EMBODIED PERSUASIVE GAME
We explore embodied interaction in persuasive games using wheelchair game input. We designed Birthday Party, a wheelchair-controlled persuasive game in which players have to complete a series of wheelchair-related challenges.

Background
Based on previous work investigating common barriers faced by persons using wheelchairs [23] and considerations for the design of disability simulations [13], we created Birthday Party, a persuasive game in which players control an avatar – a person using a wheelchair – to navigate a city and arrive at a friend’s birthday party on time. On the way, the player has to stop at different locations to pick up items for the party, but the player is running late, so completing all tasks quickly is important. The game is comprised of an overworld, i.e., a map that shows the stops the player needs to make, in a top-down perspective. One mini-game is integrated in the overworld and played from a top-down perspective; the other games are played from a side-scrolling perspective and triggered at specific locations.

Mini Game Challenges
The game features four mini-games that the player needs to complete to arrive at the party.

Crossing the street. This mini game is integrated into the overworld, and is triggered repeatedly throughout the game. Whenever the player arrives at an intersection, the game zooms in: cars are moving by quickly, and the player has to safely navigate the wheelchair to the other side of the street. If a car comes up to the player while she is crossing the street, the car stops, a honking sound is played, and the player receives a time penalty for blocking traffic.

Grocery store. When entering the grocery store, players are shown a list of items that they are supposed to pick up (cake, whipping cream, candles). Players need to navigate the store to find all items. Challenge is created in two ways: first, players have to avoid puddles of water on the ground by moving the wheelchair out of the way; if they fail to do so, they slow down. Second, players have to use their arm to reach up to shelves and collect the items; sometimes, they will be out of their reach, and they will have to try and find the item in another location.

Bookstore. In the bookstore, players have to pick up additional items (birthday card, wrapping paper) to bring to the birthday party, and find the check-out. Challenge is created by having to navigate different levels of the store without being able to use escalators. Players have to watch out for elevators instead; additionally, they need to use their arm to grab items from the shelves similar to the grocery store. Finally, players must steer around piles of books on the floor, otherwise the obstacles will slow them down.

Park. In the last mini game, the player arrives at a park to collect three flowers (tulip, chrysanthemum, rose) to bring to the birthday party. Challenge is created by the introduction of stairs that the player must avoid. Because the player must avoid stairs, flowers that are too close to the steps cannot be obtained, and must be found elsewhere.

After completing all mini games, the game returns to the top-down view of the overworld and the player has to navigate the street until she arrives at her friend’s house. There, feedback on overall player performance is provided, and the game ends.
Figure 1. Overview of the mini game challenges included in Birthday Party: Crossing the street (upper left), grocery shopping (upper right), browsing through a bookstore (lower left), and visiting a park (lower right). Each of the games features challenges specific to the use of wheelchairs, e.g., completing time critical tasks, avoiding obstacles, or finding accessible pathways.

Game Input
To study the effects of embodied simulation in persuasive games, there are two types of game input.

Wheelchair-based (embodied) input. In this condition of the game, wheelchair-based input is implemented in two ways, depending on the current view. (1) Top-down view: Players navigate the world by moving the wheelchair forward (moving up on the map), backward (moving down on the map), turning it to the left (moving left), and turning it to the right (moving right). (2) Side-scrolling view: If the player moves the wheelchair forward, the avatar moves from left to right, gradually speeding up. If the wheelchair is moved back, the avatar slows down. Turning the wheelchair to the left or right will result in the avatar ‘switching lanes’ in the game; this way, it is possible to avoid obstacles. In order to lift the arm of the avatar, the player has to raise her arm.

Traditional game input. In this condition, the player uses an Xbox 360 gamepad as input to the game. The control scheme is implemented in a way that closely matches the wheelchair (embodied) input. In the top-down view, the game is controlled by using the D-Pad: pushing up (moving up on the map), pushing down (moving down on the map), pushing to the left (moving left) and pushing right (moving right). In the side-scrolling view, the player uses the D-Pad similarly to the way wheelchair input is used; pushing up and down to speed up or slow down, and pushing left and right to ‘switch lanes’. To raise the arm of the avatar, the right thumbstick is pushed up.

Implementation
The game was implemented in C# using Microsoft XNA Game Studio 4.0 and the Microsoft Kinect SDK alongside the KINECT Wheels toolkit [14] for wheelchair input.

Figure 2. Wheelchair-based game input.
EXPERIMENT DESCRIPTION
We conducted a mixed-methods experiment to study how embodied simulation affects player attitudes.

Study Design
The presented study is a 2 (input) by 3 (time) factor design with input as a between-subject factor (embodied simulation or control) and time as a within-subject factor (1 week prior to intervention, immediately post, one week post). Participants first provided informed consent, and then completed an online survey that assessed attitudes toward disability and included demographic questions. One week later, participants played Birthday Party in one of the two input conditions. After completing the game, participants completed a post-play questionnaire that assessed attitudes toward disability and player experience. Between one and two weeks later, participants completed the follow-up questionnaire assessing attitudes toward disability. On study completion, participants received $20.

Participants and Setting
The game was played in a university laboratory on a 42 inch Panasonic TV screen. Participants used an Xbox 360 controller in the gamepad condition and a standard manual wheelchair with the foot pedals removed (for safety when entering and leaving the chair; see (Figure 2) in the wheelchair condition. Forty participants (21 female, mean age=28.43, SD=6.26) took part in the experiment.

Measures
Performance Logging
The game software logged all in-game actions and calculated a variety of performance measures; we discuss the following aggregate measures: overall time, the total time (in seconds) required to complete all tasks in the game. Furthermore, we include errors, the total number of errors (e.g., wrong selection, hitting obstacle) made in a session.

<table>
<thead>
<tr>
<th>Player Experience</th>
<th>Attitudes to Disability</th>
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<td><strong>PRE</strong> m (SD)</td>
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<td>Positive Affect</td>
<td>Inclusion 2.82 (0.66)</td>
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<tr>
<td>Negative Affect</td>
<td>Discrimination 2.94 (0.74)</td>
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<td>Competence</td>
<td>Gains 3.69 (0.54)</td>
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<td>Autonomy</td>
<td>Prospects 2.06 (0.68)</td>
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<td>Positive Affect</td>
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<td>Negative Affect</td>
<td>Discrimination 3.19 (0.83)</td>
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<td>Competence</td>
<td>Gains 3.72 (0.62)</td>
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Table 1. Descriptive Statistics.

Player Experience Measures
We collected a variety of player experience measures immediately following play using standardized scales commonly used in the assessment of player experience. Descriptive statistics are displayed in Table 1.

Enjoyment and Effort. We assessed intrinsic motivation using the interest-enjoyment and effort-importance subscales of the Intrinsic Motivation Inventory [35]. Participants rated their agreement on a 5-point Likert-scale, (1=strongly disagree, 5=strongly agree). Pleasure. To determine overall pleasure, we assessed emotional valence using the Positive Affect Negative Affect Schedule (PANAS) [38], in which participants are asked to state their level of agreement with 20 emotion adjectives on a scale (1=very slightly or not at all, 5=extremely), resulting in a score for positive affect and negative affect. Need Satisfaction. To deconstruct experience, we used the Player Experience of Need Satisfaction Scale (PENS) [35], which assesses competence, autonomy, relatedness, immersion, and intuitive control. Players agree with statements using a 5-pt Likert-scale (1=strongly disagree, 5=strongly agree).

Attitude Measures
Table 1 shows descriptive statistics for attitude measures.

Attitudes to Disability Scale. We assessed attitudes towards disability using the Attitudes to Disability Scale (ADS) [30], which was developed by the World Health Organization Quality of Life project to assess attitudes toward people with physical or intellectual disabilities. The scale has been tested with over 3700 participants and shows good reliability (α >.70). Participants rated their agreement on a 5-point Likert scale (1=strongly disagree, 5=strongly agree), resulting in the following constructs: Inclusion. Higher ratings indicate lower inclusion of people with a disability. Discrimination. Higher ratings indicate higher awareness of discrimination between people with and without a disability. Gains. Higher ratings indicate a positive attitude towards people with a disability, by focusing on the gains of disabilities. Prospects. Higher ratings indicate a negative attitude towards people with disability, by focusing on their prospects.

Research Questions
We gathered this variety of measures to enable us to answer a series of research questions using planned comparisons.

1. Did the players invest more effort with different input types (embodied simulation, simulation)?
2. Did the different input types result in different in-game performance?
3. Did the different input types yield different play experiences?

We included these questions to study how embodied simulation influences interaction with persuasive games. We expected that differences in player experience may promote differences in player attitude change:
4. Did the game produce changes in attitudes toward disability, particularly persons using wheelchairs?

5. Did embodying simulation affect the efficacy of attitude change persuasion?

6. Did attitude changes last after the intervention?

7. Did embodying simulation make a difference on the lasting impact of attitude changes?

We were particularly interested in whether changes in player attitudes are sustained over time, and whether effects are stronger when applying embodied interaction.

Data Analysis
Inter-group comparisons (simulation, embodied simulation) for play experience, affect, and performance were made using independent-samples t-tests. As attitudes were measured three times over the experiment, we conducted RM-ANOVA on the scales that measured attitude. Planned pairwise comparisons were made with α=0.05. Distributions of all data were inspected and met assumptions of normality. We report η² for all F-tests, whereas Cohen’s d shows effect size for all other significant effects. Following guidelines for qualitative research by Marshall and Rossman [22], we iteratively developed a coding scheme for qualitative data grounded in the data focused on perceptions of wheelchairs and people with mobility disabilities. We identified the following four prominent topics: (1) wheelchair-themed video games as an opportunity to experience challenges that persons using wheelchairs face, (2) effects of wheelchair input on perceived competence within the game, (3) the reflection upon one’s own abilities, and (4) usability issues related to wheelchair- and controller-based game input.

RESULTS
We organize our results by the research questions. First, we report quantitative results from the planned comparisons; we then provide explanations from the qualitative analyses.

Experience Resulting From The Input Types
Our first research questions relate to the experience depending on whether the simulation was embodied (wheelchair input) or traditional (gamepad input).

1. Did players invest more effort with different input types? Yes. An independent samples t-test showed that players who used embodied simulation reported greater levels of effort (t_{38}=2.119, p=.041, d=0.67) than those using gamepad.

2. Did the different input types yield different performance? Yes. Independent samples t-tests show a significant increase in time (t_{38}=6.103, p=.000, d=1.93) and errors (t_{38}=5.271, p=.000, d=1.67) when using the wheelchair over the gamepad (Figure 3). Participant comments highlight an awareness of these differences: “using the wheelchair felt disabling” (P36, embodied simulation), and it “did not let me perform to my expectations in the game that I had for myself” (P43, embodied simulation).

3. Did different input types yield different play experience? Independent-samples t-tests showed that there were no differences in the enjoyment of the game (t_{38}=0.712, p=.481), or in any of the measures of player satisfaction of needs (Competence: t_{38}=1.125, p=.268; Autonomy: t_{38}=0.687, p=.496; Relatedness: t_{38}=0.180, p=.858; Immersion: t_{38}=0.055, p=.957). In addition, there was no difference in the ratings of intuitive control (t_{38}=0.002, p=.999) or change in positive (t_{38}=1.814, p=.078) or negative (t_{38}=0.278, p=.782) affect. However, qualitative results suggest that participants playing the wheelchair simulation strongly focused on the effects of the input device, whereas participants using traditional game input reflected upon in-game challenges: “The wheelchair made me feel restricted and less competent than a traditional input device and me sitting or standing” (P53, embodied simulation) - “[it is] interesting to note the different challenges one has when in a wheelchair - such as finding the elevator, or not being close enough to the shelf to reach an item” (P19, traditional simulation). Also, participant quotes show that the wheelchair was perceived to be a challenging device and had an impact on how participants perceived their in-game abilities: it was “difficult, challenging, enlightening. Using the wheelchair actually felt disabling in the game.” (P36, embodied simulation).

4. Did the game yield changes in attitudes toward disability? Yes. Attitudes as measured by the ADS immediately after play were significantly improved from the same attitudes measured one week prior to play for discrimination (F_{1,38}=7.1, p=0.011, η²=0.16) and prospects (F_{1,38}=7.2, p=0.011, η²=0.16), but not for inclusion (F_{1,38}=0.1, p=.712) or gains (F_{1,38}=0.2, p=.700). Qualitative results showed that the
game prompted players to reflect upon their own situation and compare their lives to persons using wheelchairs. For example, the game made them “realize how difficult it is to use a wheelchair” (P13, embodied simulation) and “think of how real life is when one is in a wheelchair” (P11, traditional simulation).

5. Did embodying simulation affect the efficacy of attitude change persuasion?
Yes. Planned pairwise comparisons of the interaction between time and input type show that post-play attitude changes in prospects were significant for wheelchair users (p=.031, d=.40), but not gamepad users (p=.126), whereas the changes in discrimination were significant for gamepad users (p=.027, d=.48), not but wheelchair users (p=.150), see Figure 4. Comments suggest that players using the wheelchair focused on real-world challenges, e.g., that the game “made me grateful that I am not confined to a wheelchair” (P4, embodied simulation) and that it “made me realize how difficult it would be for disabled [people] to live” (P50, embodied simulation). Players of the traditional simulation reflected upon in-game challenges, stating that the game gave them “the perspective of that person and makes me realize how easy I have it and how grateful and thankful I should be for my ability to do things without extra challenges” (P49, traditional simulation) and made them “understand some of the struggles people in wheelchairs face” (P48, traditional simulation).

6. Did attitude changes last after the intervention?
Comparisons of follow-up attitudes to pre-play attitudes showed that the changes in discrimination were still present after a week (F_{1,38}=5.6, p=.024, η²=.13); however, the changes in prospects were not (F_{1,38}=1.5, p=.222).

7. Did embodying simulation make a difference on the lasting impact of attitude change (i.e., discrimination)?
Yes. Planned pairwise comparisons of the interaction between time and input type show that users of the embodied simulation sustained changes in discrimination (p=.028, d=.41), whereas users of the regular simulation did not (p=.299) – the attitudes of gamepad users had returned to pre-play levels, whereas attitudes of wheelchair users sustained the change (see Figure 4).

Summary of Attitude Changes
The premise and gameplay was successful at eliciting attitude changes. The traditional simulation was more effective in fostering immediate attitude changes regarding the discrimination faced by people with disabilities; however, the embodied simulation was better at cultivating longer-term changes in attitudes regarding discrimination. In addition, the embodied simulation was more effective than the traditional simulation at changing short-term attitudes regarding the prospects of people with disabilities. Although these attitude changes did not remain significant when measured one week later, Figure 4 shows that the trend for longer-term attitude change is similar to the effects for discrimination – the embodied simulation seems to better promote sustained attitude change.

![Figure 4](Image 3)

**DISCUSSION**
This paper investigates the role of embodied interaction in persuasive games designed to promote positive attitudes towards persons using wheelchairs. In this section, we discuss our findings in terms of psychological aspects of persuasion and traditional disability simulation.

**Persuasive Games for Attitude Change toward Disability**
Our work shows that persuasive games are an effective tool to foster positive attitudes toward people using wheelchairs. Our findings support the idea that game-based disability simulation can be applied to make individuals more aware of problems that people with disabilities experience, and that games help by allowing players to experience these challenges in the playful context of a game. In this section, we provide insights into how Birthday Party affected attitudes, outline how embodied interaction contributed to the persuasive effect, and discuss how game-based embodied disability simulation can combine the advantages of disability simulation with those of persuasive games.

**The Role of Embodied Interaction**
Our results agree with findings from psychology that suggest that embodied interaction can contribute to attitude change [7, 36]. Although our study shows no difference in player experience between the traditional and embodied simulations – suggesting that both game versions were perceived in a similar fashion from the perspective of games user research – the two versions had differing effects on player attitude change. Our results show that embodied simulations have advantages over traditional simulations in terms of the impact of the intervention and in sustainability over time. These findings fall in line with prior research on attitude change through embodied interaction and allow for interpretation by established theories.

**Theories that Explain Attitude Changes**
Positive effects of embodied interaction have been shown on depth of processing, recognition, and acceptance of
information [26]. Psychological theories explain that embodied interaction may have higher persuasive power, because: (1) it conveys information through a peripheral channel, avoiding the precise processing of arguments, which can be immediately rejected. Therefore, the message is more likely to be accepted (Elaboration Likelihood Model) [31]; (2) it adds full-body motion to process information not only through eyes, ears, or tactile feedback, but through a proprioceptive experience that allows for deep processing and longer recognition (Perceptual Symbol Systems) [4]; and (3) observing oneself performing the embodied interaction, followed by the reflection of which attitudes prompted the demonstration of a behaviour, could motivate a shift in attitude (Self Perception Theory) [5].

In the context of our game, we show that compared to traditional game input — which emphasizes the challenge internal in the game — embodied interaction may also draw attention to the challenges external to the game. While the persuasive game itself allowed us to convey the message that people using wheelchairs experience different challenges in their everyday life, embodied interaction allowed participants to have a first-hand experience using a wheelchair, forcing players to put themselves in the same situation as a person using a wheelchair. Doing so poses the question of how a player could reject a person using a wheelchair if she could be in the same situation. To solve this conflict, participants seem to temporarily reduce their prospects towards people with disabilities, and increase awareness of discrimination. The proprioceptive experience of the embodied interaction leads to deeper processing of the differences, but not the prospects, between people with disabilities and able-bodied individuals, and stabilizes the change of attitude over time. This would explain why the embodied simulation led to improved attitude in terms of discrimination, and not prospects.

**Game-Based Embodied Disability Simulation**

In contrast to traditional disability simulation that takes place in real-world settings [15], game-based disability simulation offers the opportunity of creating a protected environment in which players can experience challenges associated with specific disabilities, e.g., the use of wheelchairs. While previous approaches toward disability simulation have applied traditional game input and therefore omitted the physical dimension, our work shows that embodied interaction can in fact be a means of reintroducing the physicality of traditional disability simulation while maintaining the advantages of video games, i.e., the opportunity to balance difficulty to create achievable challenges that do not discourage players.

**Designing Effective Embodied Persuasive Games**

Our work shows that the interface affects how player attitudes are influenced by persuasive games, and that designers need to consider these effects when creating embodied persuasive games. In the following section, we outline challenges and opportunities that can be leveraged to support the creation of effective persuasive games.

**Designing Physical Player Input in Embodied Persuasion**

Embodied interaction naturally includes a physical dimension. In game development, this aspect has previously been approached from the perspective of exergame design, i.e., games that aim to provide physically stimulating experiences, and draw from intense physical player effort to create a challenging player experience [25]. In embodied persuasion, additional considerations are necessary to design adequate physical player input.

**Understand the difficult role of physical player effort in the persuasive context.** Motion-based games such as exergames have previously integrated physical effort to challenge players and improve player experience. In the context of embodied persuasive game design, this principle has potential beyond player experience. Our findings support suggestions by previous work stating that physical effort may contribute to persuasion [21]: our results show that the physical effort of embodied simulation may promote lasting attitude change. Therefore, designers wishing to invoke attitude changes in players can build upon embodied interaction to facilitate persuasion. In this context, it is important to carefully balance the role of physical effort. For instance, a game that aims to promote positive attitudes towards persons using wheelchairs needs to allow players to see that despite the impact of a disability, individuals can still be physically competent and overcome physically challenging situations.

**Effects of Embodied Game Interaction on Persuasion**

Our results show that it is important to consider the impact of embodied interaction when designing persuasive games.

**Be aware that the usability of embodied game input has an impact on persuasion beyond player experience.** Our results reveal interesting differences in the way players attribute difficulties related to the input device. Participants who used a gamepad generally seemed to make a distinction between challenges related to the input device, and in-game challenges. In contrast, when using embodied input, participant comments show that participants associated usability issues caused by the input device with the persuasive context, i.e., players who found it hard to control the game with a wheelchair concluded that navigating a wheelchair is a difficult task. The perception of difficulties related to interaction with motion-based input is interesting when considering findings that suggest that the position of our body influences how we feel about a matter (e.g., negative affect increases if body is in an uncomfortable position) [7], an effect that may play a role in embodied persuasive games.

**Understand that embodied interaction may divert player attention from in-game content.** Our results show that participants using embodied game input focused on the
input device. In addition to increasing game difficulty, embodied interaction may also divert player attention from in-game content, potentially reducing the persuasive power of game mechanics and narrative. When employing embodied input, designers have to account for this aspect by creating intuitive embodied game input that allows for easy entry into play. Furthermore, understanding that the embodiment has been shown to increase player focus on the input device is an important step towards adjusting the pacing of the game by balancing in-game challenge, story elements, and stretches of physically demanding interaction in a way that allows players to attend to each element.

LIMITATIONS AND FUTURE WORK
A general challenge in the evaluation of persuasive games that address socially sensitive attitudes is the measurement of attitudes and the risk that participants may provide socially desirable answers. We applied the Attitudes to Disability Scale (ADS) [30], which is an explicit measure, meaning that participants are required to consciously reflect upon their opinions. The inclusion of implicit measures of attitudes, as demonstrated by [1], can provide additional insights into subconscious attitudes. Additionally, there are four other aspects of our study design that need to be considered when generalizing the results. First, our study only addresses one type of mobility disability (wheelchair use), and future work needs to explore whether our approach can promote positive attitudes toward persons with other disabilities. Second, players using the wheelchair took longer to complete the game and thus experienced a longer exposure to our intervention; this may have affected the persuasive process. Third, although we did measure the development of participant attitudes over time, our post measurement took place one week after the intervention. To further study the effects of embodied interaction in persuasive games, conducting a longer-term study with post measurements that take place after a longer period of time might provide insight into how attitudes develop over time; increasing the frequency of the intervention may also affect attitude change. Finally, embodied interaction as explored in this paper is only suitable for persuasive technologies that include a strong physical dimension easily captured by a system, e.g., intuitive game controls that can be combined with other game mechanics in persuasive game design. For persuasive games that cannot build on physical attributes, exploring alternative approaches towards embodied persuasion might be valuable, e.g., leveraging the fact that certain postures and facial expressions have been demonstrated to facilitate persuasion [7].

CONCLUSION
Persuasive games can be an effective means of changing player attitudes or behaviours. Our work demonstrates that embodied interaction can be successfully applied to support the process of persuasion. It is a step toward capitalizing on the positive relationship between embodiments and persuasive processes studied in psychology, and applying it to video game design, thus further contributing to theoretically-grounded approaches toward persuasive game design. Applying embodied interaction in a persuasive game for promoting positive attitudes towards people using wheelchairs opens up new perspectives for disability simulation. By combining the strengths of video games with aspects of traditional disability simulation, game-based disability simulation can be a powerful tool to allow able-bodied individuals to better understand challenges that people with disabilities face. This research demonstrates that embodied persuasive games can be applied to foster positive attitudes towards persons using wheelchairs, potentially reducing barriers between able-bodied people and people with disabilities. Thereby, embodied persuasive games can help promote inclusion and make an important contribution to the ultimate goal of improving the quality of life of people with mobility impairments.

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REFERENCES
of Physical Education, Recreation & Dance 80, 8 (2009), 19-24.


37. Stokes, B. Videogames have changed: time to consider ‘Serious Games’? The Development Education Journal, (2005), 6–13.
