A Thing of Beauty: Steering Behavior in an Interactive Playground

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ABSTRACT
Interactive playgrounds are spaces where players engage in collocated, playful activities, in which added digital technology can be designed to promote cognitive, social, and motor skills development. To promote such development, different strategies can be used to implement game mechanics that change player's in-game behavior. One of such strategies is *enticing* players to take action through incentives akin to game achievements. We explored if this strategy could be used to influence players' proxemic behavior in the Interactive Tag Playground, an installation that enhances the traditional game of tag. We placed the ITP in an art gallery, observed hundreds of play sessions, and refined the mechanics, which consisted in projecting collectible particles around the tagger that upon collection by runners resulted only in the embellishment of their circles. We implemented the refined mechanics in a study with 48 children. The playground automatically collected the players' positions, and analyses show that runners got closer to and moved more towards taggers when using our enticing strategy. This suggests an enticing strategy can be used to influence physical in-game behavior.

ACM Classification Keywords
H.5.1. Multimedia Information Systems: Artificial, augmented, and virtual realities; H.5.2. User Interfaces: Theory and methods

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Steering behavior; persuasion; entice; play; proxemics; social; interactive playgrounds; augmented reality; interactive floor.

INTRODUCTION
There is a growing interest in supporting playful activities that require physical interaction, which can be met by using technology to create ambient intelligent environments that house these activities [20]. One category of such environments is

Figure 1. Young children playing on the interactive tag playground. The young boy with an orange circle projected around him is *it*, the players with partially green circles are temporarily shielded from being tagged.

described as interactive playgrounds, spaces that make use of digital technology to stimulate collocated playful activities that include social and physical elements of traditional play [20, 28, 38]. The type of activities that are offered vary greatly, ranging from walking or running around [30], to sliding [27] or jumping [36]. In these games, the body of the players becomes an integral part of the interactions and its movement involves more than just posture changes, setting it apart from most commercial movement-based (console) games. In general, interactive playgrounds are room sized environments that encourage forms of play that foster cognitive, social-emotional, and/or motor skill development [2, 12, 20, 27].

In many cases, these developmental goals are reached by carefully designing interactions that deliberately influence or guide player in-game behavior in specific directions. We call this *steering* of player behavior. Steering has been used, for instance, by Landry and Parés to increase physical activity by changing the rate at which mandatory collectable objects appear [11]. Regarding the social-emotional domain, it can also be used to change how players (students) interact with each other. In an implementation of the game of pong on our interactive playground, we increased the mutual coordination of their movements, by virtually linking players with a line in a playground [34]. We have also balanced a game of tag by

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taking into account players' skill differences, and influenced with whom players interacted [35].

Steering player behavior is clearly relevant when designing games that aim to promote certain type of behavior. This can be combined with the advent of accurate and affordable sensors, which allow interactive playgrounds to automatically measure and analyze player behavior in-game [11, 15]. The positions, player interactions, and other types of movements can be recorded, which provides interesting parameters that might otherwise be hard to obtain. While this is useful for analysis and evaluation purposes, including doing tests without interfering too much in the game, it also allows game designers to implement strategies for behavior steering that are adaptable or adaptive based on how players play the game or interact with each other. Nonetheless, to be able to reliably influence player behavior, we first need to build up a repertoire of game mechanics and interventions that dependably and controllably steer behavior in various directions, and systematically evaluate their effect.

In this paper we bring together various parts of our ongoing research to work towards this goal. We use an augmented version of the game of tag [16], in which we steer behavior [35], use automatic measurements to analyze children's play [15], and use insights gained over hundreds of play sessions, in order to systematically investigate ways of steering behavior to take specific actions. The added value of this paper is primarily that we investigate in more depth and detail how we can steer physical behavior of children in such games. We validate theory, with a comparative study using automatic measurements, in the domain of influencing players' physical play behavior in interactive playgrounds.

Steering Player Behavior

Behavior steering in interactive playgrounds is primarily about in-game change of (play) behavior and not about long-term change of lifestyle behavior (e.g. smoking, (un)healthy diets, medication etc.). Within this scope, we have identified different strategies used for behavior steering that have been applied previously in embodied play studies. In the first one, players are *required* to take certain actions to control the game. For example, Parés et al. *require* players to stand in a ring in order to make their interactive fountain emit a stream of water [19]. Without performing such actions, players can not play the game as intended.

In the second strategy, the game *insists* that players do something by giving them game-outcome related rewards. An often found implementation of this strategy is giving players power-ups or rewards for taking certain actions in the game. For example, van Delden et al. *insist* players to collect a power-up item during tag games that makes it easier for players to avoid being tagged [35]. Often, although not necessarily, this strategy introduces a positive feedback loop: players that are good at the game are also more capable of collecting items, which increases their chances to perform well in the game, which makes it more likely for them to keep on collecting items [9, 23]. Such a reward system is always strongly tied to the primary game mechanic and win/loss condition of a game.

We believe that these two strategies, *requiring* and *insisting*, can be quite forceful in how they steer player behavior. In the current study, we adopt and explore a third strategy by which behavior can be steered in interactive playgrounds, one where players are not *required* or *insisted* to take action, but rather *enticed* to do so by the game. The concept behind this strategy is related to the concept of *nudging*. Nudges are a way to change behavior in a way that is not (significantly) related to the users' economic incentives and does not obscure options [31]. In a game-like context, we see that the other two strategies often rely on providing players with 'in-game economic incentives'. In other words, the *requiring* and *insisting* strategies employ rewards or responses that are related to the main game-outcome, e.g. power-ups, shields, additional lives, or reaching the main goal. In relation to game design, nudges rather correspond to the introduction of secondary goals and rewards, just as is done by e.g. achievements [8].

We propose to steer player behavior by *enticing* players to take action by designing game mechanics that are achievement-oriented rather than ones that afford actions that lead to functional advantages related to the core mechanics of the game. In digital games, a player's achievements can be accompanied with making an avatar look nicer, for instance adding a hat to an avatar in Team Fortress 2 [8, 14], which, on its own, has no useful impact on the game outcome or the performance of the player. However, Hamari and Eranti point out that it is important to realize that the aesthetic function of an object (e.g. wearing a hat and looking nice) might provide players an important goal of their own. This emergent goal and meeting the conditions to obtain such an achievement, 'can entice players to try out new features and ways of playing', and can therefore influence player behavior [8](p10). In fact, every achievement reward, or at least most of them, do not provide advantages that serve towards the primary goal of the game. Instead, they function rather as a handicap towards success, setting conditions that may be challenging to meet and drive players away from the primary goal [8]. Similarly, in an *enticing* strategy, the added mechanics are optional; the offered reward does not contribute towards achieving the primary game goal and if anything, using them can make the game more challenging.

The *enticing* strategy for steering has some advantages when compared to other forms of behavior steering. One, fitting the libertarian approach of nudges [31]: it is more subtle and less forceful than other strategies for steering play, which, especially working with children, can be preferred in many contexts. Two, we argue that it will be easier to transfer to other similar playgrounds, as the introduced game mechanic does not need to be closely tied to the existing core mechanics of a particular game. The reward does not need to be part of the feedback system of the game [9]. The implementation of our *enticing* strategy for an interactive tag playground (ITP), might also work in an interactive team-pong playground, or on an interactive slide. This can save time and allows for better transfer of research results. Note, that although the players' actions do not need to be part of the feedback system, they can be influenced indirectly, where the enticed actions for instance might introduce risk taking behavior resulting in a negative (i.e. stabilizing) feedback loop. Three, this way of steering allows us to switch the interventions on and off more easily, providing additional ways to steer behavior with adaptable and adaptive systems.

In this paper we will show that an *enticing* strategy can be used for steering behavior in at least one meaningful dimension of interactive play: steering proxemics [7].

Operationalized Contribution: Changing Proxemics

As a proof of concept of our enticing strategy, we aimed to steer proxemics in a game of tag. We do this by designing a game mechanic that aims to get runners closer to the tagger. Proxemics can be operationalized into distance, orientation, identity (distinguishing players), movement, and location [6, 18]. In line with this, we propose two hypotheses to show that our game mechanic can influence similar aspects of proxemic behavior: 1) the distance between taggers and runners becomes smaller, and 2) movement in the direction of the tagger occurs more often. In the specific context of tag games, this can be seen as a form of risk taking, which might be meaningful on its own as coming closer to a tagger increases the chance of getting tagged and might be appropriate when balancing games or changing engagement levels. This also exemplifies that the added *enticing* game mechanic has no positive effect on the primary game outcome for the player involved. Indeed, in this particular case, the strategy has the opposite effect: it makes the game harder. Given the potential benefits of a behavior steering strategy that employs enticement, we show its applicability in interactive play by adding a possible action strongly related to the aim of changing proxemics (players can collect particles close to the tagger) which is rewarded with the embellishment of game objects (players' circles) to steer meaningful play behavior (proxemics) in an interactive playground.

RELATED WORK

Game Design Principles

We build upon game design principles such as Schell's lenses. The players are rewarded with beautiful circles that provide '*endogenous value*' to the mechanic. As Schell mentions in his analyses of Busby versus Sonic, only collection for the sake of collection is likely to be less successful [24]. The created variation of the game also has a certain '*juiciness*', with only a limited amount of interactions and easily controllable actions the player gets more power and rewards [24]. The well known MDA framework as well as Schell, and Salen & Zimmerman explain that player's actions and experience can only be designed for indirectly, players do not always follow anticipated actions or show anticipated responses [9, 23, 24]. It is also important to realize that it is likely that not all game design principles will hold for movement-based games [10]. There are several guidelines, models, terms, and best practices that are insightful when building interactive playgrounds and designing interactions for these games [4, 10, 22, 26]. Isbister and Mueller explain that in movement-based games players play in a different tempo and scale than precise and rapid button presses in normal games. Furthermore, due to the more exaggerated movements visible to the spectators it changes the spectator-gameplay relationship [10]. We will thus also include this aspect of spectatorship into the design of the evaluation study. So although we can anticipate the effects of our intervention, it is all but certain, and still insightful to study the applicability of an *enticing* strategy.

Relation to Work on Enticing Players

There have been several studies on enticing players to interact with public displays, playgrounds, and other interactive systems. However, this is often done in order to get people interacting: seducing players into interaction taking into account stages of play [4], making players curious and elicit exploratory behavior [32], or overcoming social embarrassment barriers of players [3]. Here, we study *enticing* players to change their behavior (i.e. steering) once they are already interacting. Outside the field of embodied interaction there was a study more in this direction. Anderson et al. analyzed, modeled, and showed that with the use of badges, user's online activity was steered [1]. This shows that the idea of *enticing* is not new but the implementation to change ongoing play, in combination with showing the applicability in a structured comparative study, does add to the growing body of work on physical play.

Interactive Playgrounds

Interactive playgrounds can exist in many forms. They can be responsive environments where children have to come up with their own meaning of objects and interactions, enabling open-ended play patterns [2, 28, 25]. They can also implement much more specific games with instructions, rules, and game goals (and outcomes) [11, 35, 37]. Spanning a continuum between the two, somewhere in the middle would be most of the camera/projector exhibits, defined as *social immersive media* by Snibbe and Raffle [26]. These provide interactions that (often) contain a certain narrative, creating exhibits that range from performative dances to a more goal-oriented genre with a clear ending [26]. This paper reflects work on installations that implement specific games, where we can let the game function as a referee, and can augment existing games [16]. The variation of a tag game that is part of our *enticing* way of steering, gives an additional element which places this version slightly more towards the open-ended play side; children can set additional goals, can discuss about it, and have to decide on their relative importance.

Changing Proxemics in Interactive Playgrounds

There are various movement-based games (interactive playgrounds) that contain game mechanics to influence proxemics, trying to get people closer to each other [18]. These examples show it is a relevant research topic in our field. *Proxemic Pong* includes penalizing players that are too close, in order to change distances between players [6]. *Jelly-Stomp requires* people to get close to each other in order to stomp an interactive floating device [18]. *Bubble Popper* is a game that revolves around popping colored shapes on a vertically oriented interactive projection [33]. In this game, the shapes move in order to get competing players to make physical contact with each other. *Boundary Functions* is an exhibit that contains an educational message in the form of an interactive Voronoi diagram [26]. It uses players positions to project lines

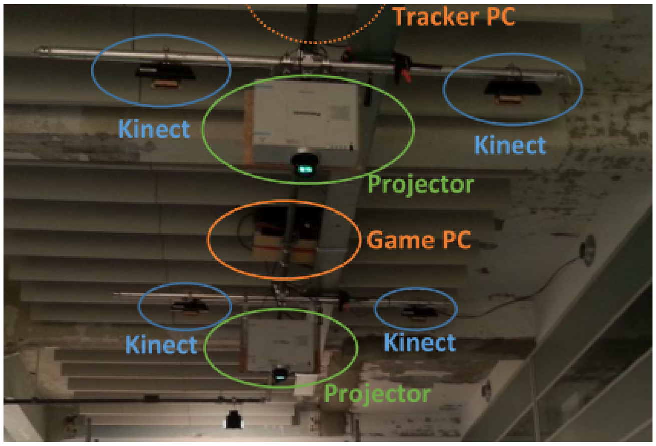

Figure 2. The hardware and construction for the Interactive Tag Playground at the art gallery.

on the floor between players, and relates to 'personal space' and proxemics. Proper use (and well targeted change) of proxemics of players, or players and objects, can be an essential part of engaging HCI [6].

THE INTERACTIVE TAG PLAYGROUND

For our study we made use of an existing game, the Interactive Tag Playground (ITP). We call the system itself a playground as it allows for implementing different variations and games, though we currently focus on the game of tag. The ITP consists of 4 Kinects and two wide-angle projectors mounted near the ceiling (about 4 meters high), see Figure 2. One PC tracks the players based on the depth images of the Kinects, while a second PC runs the game. The tracker algorithm performs well, it has a limited number of switches of tracked players, provides useful measures of movement, and can be used for insightful analyses [15]. The game we use for this study is based on the traditional game of tag with one tagger. Around each player the ITP automatically projects a circle, this happens upon entering the playground and no additional calibration, markers, or sensors are needed. This provides a playground with easy stepping, easy stepping out, which seems appropriate for public spaces [29]. One player is randomly assigned as *it*, and gets the orange circle, see Figure 1. Players tag each other by letting their circles overlap, after which the new tagger gets an orange circle. The game primarily targets children in the age group of eight to twelve, because of the simplicity of the game slightly younger children can play it as well.

Three Versions of Behavior Steering in the ITP

As an example of behavior steering we want runners to get closer to the tagger. Taggers periodically emit particles that runners then could collect. The particles are emitted with some aesthetically appealing randomization, they differ in size, in the duration before they disappear, and in their relative velocity compared to the tagger, see Figure 4 and 6. Runners can collect the particles by letting their circle collide with the particles, a *'plop'* sound is played at that moment. If a runner collects enough particles the circle of that runner changes in visualization, see Figure 5. This collection should have a clear effect on the proxemics. In an attempt to keep the game focused primarily on the tagging interactions, the circle of a player is reset once tagged.

Figure 3. Tagger running towards a runner, the chased runner has an embellished circle, see the other runner in the top of the image.

In order to exemplify the three strategies of steering we have three versions of the ITP. For the first strategy, we always *require* taggers to come close to runners, they have to let their circle overlap with that of a runner (the *baseline* version, without adding particles). For the second strategy, if players collect the particles they are rewarded in the primary game-outcome related way, we use *shields* that temporarily prevent players from getting tagged (the *insisting* way of steering). To make this clear to the players, a number of green rings are formed around the circle. For the third strategy, players are *enticed* to come close by rewarding collection of particles only with embellishment of their circle, the circle becomes more complex and beautiful, see Figure 5. We call this last variant *swag*.

EXPLORING AND IMPROVING THE INTERVENTION

Prior to performing a structured user study, we observed many play sessions to investigate our *swag* intervention, in order to improve the intervention, to create an appropriate study design, and to see if children would like it as well.

The playground we used for exploring and improving our intervention had a size of about 4 by 5.5 meters. We were invited to exhibit the ITP at a local art gallery, where it would remain for a period of two months, see Figure 3. Making this transition from lab to a more public space, and dealing with a high number of users is a challenging task [19]. We had to make a version of the ITP that could be started with a press of a button, take into account the daily practice of the space and more importantly the rules and ethics of this environment.

Organizing Play Sessions at an Art Gallery

The gallery is a non-profit organization that is open for the public, free of charge, 8 hours a day. We only observed play

Figure 4. A tagger, the same player that was previously a runner with an embellished shape in Figure 5, has just emitted a trail of particles.

on the 18 days that the gallery organized workshops. During these workshops no other visitors were present, each time only one or two primary school classes. Based on the number of games we started we know that over 600 children in total played during these workshops. The age of the children ranged from approximately 4-13 years. The groups' visits to these workshops, of which playing in the ITP was only a small part, took about one to two hours, and varied in size from roughly 20 to 50 children (on average 33). This meant there was limited time to let all the visiting children play in the playground.

Consent and communication with schools and parents was managed beforehand by the art gallery according to their internal protocols. One researcher first explained the basics of the game and showed how the game is played by tagging a facilitator from the art gallery. We explained that in some games balls (particles) appeared, that could be collected, we omitted explanations about how the particles exactly worked. Children were always first asked to play and only participated voluntarily. We also instructed the children not to leave the boundaries of the game. If necessary, we reminded them during the game. We started with the three versions, the *baseline*, the *shield*, and the *swag* version, each session we automatically alternated between them. Similar to what is suggested by the Rapid Iterative Testing and Evaluation (RITE) Method [13], at the end of each day in the first few days we made several changes (e.g. circle size, the visualizations, and duration of a game). In the last few days we played the *swag* version more often in order to explore a change in how the particles were emitted.

The context had the following 'restrictions': 1) explanations for the tests had to be brief, clear and consistent, 2) the use of questionnaires was discouraged and impractical, and 3) use of non-anonymous data including video recordings was not allowed. These restrictions actually helped us to work towards the user study, as the restrictions, especially one and three, were also limitations for our user study. In both the workshops

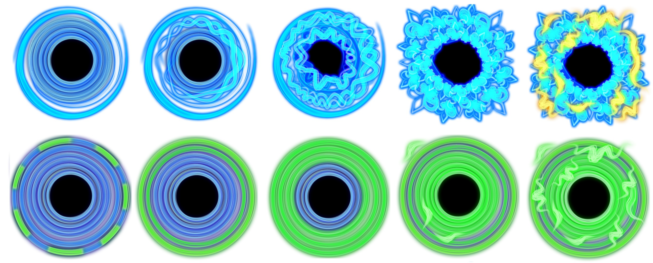

Figure 5. Circles depending on the number of particles collected (increasing from left to right). On the top the aesthetics of circles used for the *swag* version and in the bottom the circles for the *shield* version.

and our study there was a limited time to play tag, and parents were reluctant to have their children participate if we took video recordings. Only two teachers during two workshops at the art gallery were given permission by their school and the parents to take pictures and share these with us, these pictures were used for this paper.

Observations and Improvements

Based on our observations during the play sessions at the art gallery we were able to fine-tune the game and we worked towards an effective user study. We removed a pre-recorded explanation to speed up sessions, we limited the game duration to better fit the extent of the visit, we changed the players' circle size to fit the size of the playground and the children's abilities, and we changed the duration of the cool-down period before tagging someone back and improved its visualization. Most importantly, we changed the particles' size, occurrence rate, and way of spreading, see Figures 6.

We noticed a large difference in how children played the games, seemingly related to among other things the children's age, gender, and stamina. We observed no real difference in playing for the few children that played the game for a second time. The youngest children, based on the group with which they visited about four to six years old, liked the experience but did not play the game in the expected way and instead were often distracted or overwhelmed. For example, see how the young girl is staring at her circle instead of running away in Figure 1.

We observed that the older children realized early on in the game, often within an estimated twenty seconds, that the particles changed the appearance of their circles. The rules of the shield intervention were not always recognized as quickly. It is not surprising that the shield mechanics were harder to interpret, as recognizing how the shield protected a runner from being tagged not only needed the runner to collect several particles, it also required that an attempt had to be made by the tagger to tag this runner while he/she had the shield. Nonetheless, in both particles conditions we did see children gathering these particles intentionally.

We observed several children deliberately collecting and liking collection of the particles, especially the resulting embellishment of the runner's circle. Utterances of spectators and players confirmed that the graphics were indeed appealing for the children. We heard things like: *'wow look at X's circle'*,

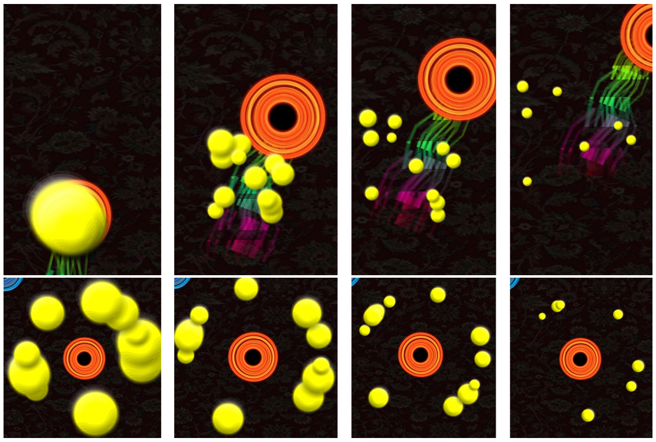

Figure 6. Visualization over time of two versions of emitting particles. In the first version (top) we used a wider spread of particles based on the velocity of the tagger, instead in our study (below) we used a more effective spread of particles keeping them in a circle around the tagger.

'catch those balls, it makes your circle more beautiful', or *'ohh no, I am tagged but I finally had such a beautiful shape'*.

Although we did not count certain responses nor asked children about whether they had fun, there were clear observable indications that the ITP was fun for the majority of the players. Most of the children asked us, they actually even begged us, to play again, which can be linked to a fun experience [21]. We got very positive and enthusiastic responses from the children, teachers, and parents that were present during the workshop. People from the art gallery told us that several children even came back some days later with their friends or family members in order to play in the ITP again. Using the observations and these positive responses about the children's play we proceeded to set up our user study.

STUDY: STEERING PROXEMICS IN THE ITP

Study Design

Based on our observations we only included children in our study that were at least five years old. The differences between the children also made us choose for a within-subject (altering the order) as the effects should be due to the intervention and not due to imbalanced groups. This meant that there was a more limited time for the play sessions, as we wanted to give all the visiting children the opportunity to play. We decided to simply omit the shield intervention, as such a strategy for behavior steering has already been shown to change behavior [11, 35]. Instead we did a comparison between the normal ITP (*baseline*) and one with a more enticing way of steering (*swag*), to demonstrate that this strategy for steering behavior can be applicable and effective. This means that we have not compared the relative effectiveness of the shield and the swag mechanics.

Participants

We organized field trips for two elementary schools, taking one morning per field trip. These field trips allowed us to analyze how 48 children played interactive tag. We had 18 play sessions, from these we omitted six sessions from analysis. Four sessions had to be omitted as it included one or more children of whom his/her guardian had not given permission for using the data for scientific purposes. Two other sessions had to be omitted for technical reasons, as sunlight had interfered with the recognition system. The remaining 12 sessions (48 players) were analyzed. The first 8 sessions were done with students from one school and in the age range of 8-12 years. The last 4 sessions were done with students from another school, in the age range of 5-9 years.

Figure 7. Context and location of the user study, 4 children are playing tag at our lab during a field trip. There are some spectators at the sides. We anonymized , blinded, and color corrected the image.

Context

We used a permanent installation of the interactive playground in one of our labs, this version is slightly bigger than the one at the art gallery, both sides are 5.5 meters, see Figure 7. During most play sessions, there would be a limited number of spectators consisting of the next group of children, a teacher, or the previous group. During the field trips children engaged in interactions with a variety of interactive products in our lab: several student projects, robots, and interactive installations (including the ITP).

Procedure

The field trips were approved by the faculty's ethical committee. We had information letters and signed consent forms for all children that participated in the study. These were distributed via the teachers several weeks before these field trips.

We gathered four children at a time from the other field trip activities in a room next to our playground. In some cases a group of children walked towards the playground of their own accord. We always asked children if they wanted to play. We explained and demonstrated the *baseline* game for each group. We alternated the order in which they played the two conditions: *baseline* and *swag*. We explained the game, 4 children played, and the game lasted 90 seconds. In order to start at a clearly recognizable moment in time we started the game with a countdown consisting of both visuals and sound *'3,2,1,GO!'*. The time between the two sessions was enough for the children to catch their breath. In order to prevent differences between starting positions being of influence, we instructed them to stand at the four corners of the game. We indicated these positions with a projection on the floor. Before the *swag* condition we explained the workings of the particles. Based on our experience we had already seen that most children would understand the workings of particles eventually, by trying them out. However, we wanted them to have an effect earlier on in the session, thus we slightly changed this explanation compared to the one given at the art gallery. We explained that collecting balls (particles) was possible and would make their shape nicer, but that by doing so they would increase the chance of becoming the tagger. We told them it was up to them to make use of collecting these balls or not. Log files of the position of the players and their role (tagger or runner) were automatically saved.

Measurements

For the core purpose of the study the automatic measures of players' locations sufficed. Automatic measurements have been used to track a variety of relevant information, including players' positions [15, 17]. The relative position of players is the core element of proxemics: we use both the distance between taggers and runners, and the orientation of moving runners with regard to the tagger (do they actually move towards the runner more often?). We limited discussions after the sessions to keep reasonable throughput of participants in the limited duration of their visit. We omitted video recordings (and analyses) but we did observe the play and wrote down any interesting utterances made during the game.

The ITP provides positions per 'frame', approximately 18 times per second. We used a median filter of 5 frames on the players' positions to reduce noise on x and y positions separately. The distances to the tagger were averaged over the three runners each frame. This average distance per frame was then averaged over all frames of the session. This means that the few tracker issues regarding player switches were unlikely to influence the results. The few frames where one or more players are missing for several frames are automatically omitted from analysis, this made up for 4.7% of the frames.

Regarding the direction of the runners with respect to the taggers, we needed a more comprehensive method. The angle was calculated by taking the difference between 1) the direction of the runner based on the velocity vector, and 2) a vector linking the runner's and the tagger's positions. In this way an angle of 0° means the runner is running straight towards the tagger. For the direction measurements we used the smallest absolute angle, so -10° or 350° is counted as 10°. For all frames we only counted the direction of runners that are actually moving. We removed displacements below 0.01 meter 'per frame', approximately 0.67 km/h. This made up for 7.8% of the remaining frames per runner, especially the values at the first few seconds of each game where children had to look who was *it*. To reduce outliers from switches in the tracker (these did not influence the distances between players as these are independent of switches of players' tracks) we also removed those frames where players allegedly moved faster than 25 km/h. This made up for an additional 0.2% of frames per runner. Although results are quite stable showing the same results independent of such parameters, to further reduce possible influence of noise we also used a median filter on the angles. We applied this on these angles over 11 frames (about .6 s). We only used these value of each 11 frames. We then counted the values where runners were walking towards the tagger (operationalized as those angles below 60 degrees) divided by the total amount of valid angles of moving runners for each session.

Hypothesis

We set out to influence the proxemics, especially the distance between players, we expected runners would gather the particles that were emitted from the tagger during the *swag* sessions. Therefore, the average distance of runners to taggers was expected to be smaller for sessions in the *swag* condition. We based this mainly on Tetteroo et al. that observed that interpreted status in the game can be a powerful motivator for children in an interactive playground [30]. We test our first hypothesis using a one-tailed paired-samples t-test comparing the *swag* condition to the *baseline*, based on the average distances between taggers and runners in cm (one value per session, n=12).

HYPOTHESIS 1. *The distance between runners and taggers is smaller in the swag condition than in the baseline condition.*

We expected that runners would be more inclined in the particle conditions to walk towards taggers in order to gather the particles. Therefore, moving towards the tagger was also expected to be visible in the angle at which runners moved compared to the position of the tagger (this includes walking towards the taggers' back). We expected runners would run more often (occurrence rate per session) in the direction of the tagger ($<60^o$) in the *swag* condition. We test this second hypothesis using a one-tailed, paired-samples t-test comparing the *swag* condition to the *baseline* condition, based on the averaged ratio of runners walking towards the tagger (one value per session, n=12).

HYPOTHESIS 2. *Runners move in the direction of the tagger more often during the swag condition than in the baseline condition.*

RESULTS

Besides the quantitative measures to investigate the hypotheses it is good to have some idea of whether the particles would influence the play experience. During the discussions after both conditions in six groups all players indicated they preferred the *swag* version, in one group three players preferred the *swag* version and one player the *baseline*. In one group all players liked both equally, and in one all liked the *baseline* more. We mentioned this preferences on a group basis, as peers can influence each other in their responses. We also noticed them making many positive remarks about the particles and *swag* circles: *'Look at my circle!'*, *'Yess! Yeah I want those spheres'*, *'Wow he is gold, yes gold!'*, *'Check mine!'*, or *'Yes I have the most beautiful one!'*, again demonstrating that the embellishment was indeed found more beautiful.

Hypothesis 1

We looked at the data for the individual play sessions, the distances were averaged over the three runners each frame. Table 2 shows that on average in 11 of the 12 sessions runners come closer to the tagger. We did a one-tailed, paired-samples

Table 1. Ratio of players moving towards the tagger (angle<60°) when they are moving, averaged over all values of all the runners for each session, both for the baseline (b) and swag (s) condition.

#	1	2	3	4	5	6	7	8	9	10	11	12
b	0.14	0.081	0.13	0.15	0.11	0.18	0.11	0.12	0.17	0.17	0.13	0.17
s	0.20	0.15	0.23	0.23	0.22	0.26	0.28	0.19	0.19	0.27	0.28	0.26
s-b	0.06	0.07	0.10	0.07	0.11	0.08	0.18	0.07	0.03	0.10	0.15	0.08

Table 2. Average distances between a runner and the tagger in meters. In session one we started with the *baseline* and then alternated the order.

#	mean (baseline)	mean (swag)	std (baseline)	std (swag)
1	2.24	2.21	0.54	0.60
2	2.53	2.38	0.55	0.59
3	2.51	2.39	0.65	0.65
4	2.54	2.41	0.55	0.50
5	2.36	2.27	0.60	0.58
6	2.63	2.50	0.60	0.63
7	2.47	2.27	0.52	0.50
8	2.69	2.35	0.52	0.51
9	2.63	2.74	0.57	0.78
10	2.81	2.53	0.81	0.67
11	2.56	2.41	0.63	0.64
12	2.83	2.68	0.69	0.74
avg.	**2.57**	**2.43**	**0.60**	**0.62**

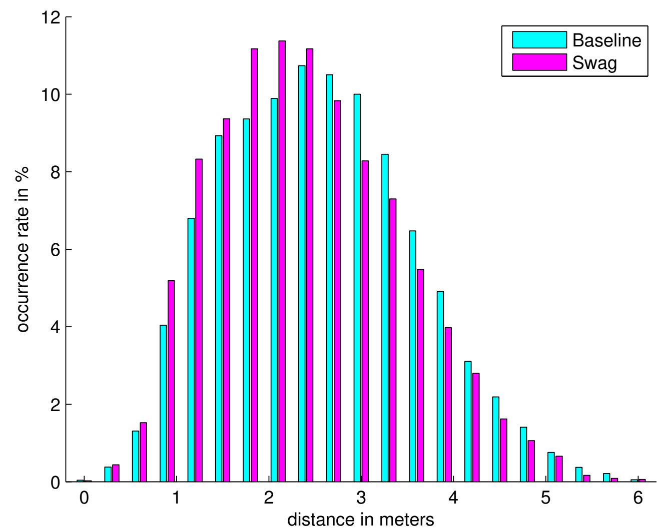

Figure 8. Distance between the runner and the tagger for the different conditions in the user study.

t-test (n=12). On average, the distance between the runners and the tagger was significantly smaller in the *swag* condition ($M = 2.43, SE = 0.05$) than in the *baseline* conditions ($M = 2.57, SE = 0.05$), $t(11) = 4.13$, $p < 0.001$, $r = 0.78$ [1]. Runners were about 14 cm closer to the tagger on average during the *swag* condition. We bundled together into a bar graph all the distances of all runners to the tagger, this also shows a similar visualized result, see Figure 8. It shows that runners are often closer to tagger for the *swag* condition, seen as higher bars to the left for the *swag* condition. For the *baseline* condition it shows that runners are often farther away in this condition, seen as higher bars to the right. These results lead us to accept Hypothesis 1.

Hypothesis 2

Besides the distances, we looked at the movement direction of runners with regard to the position of the tagger. If we look at the session-based ratio, we see that players more often moved towards the runner (angle<60°) when they were moving in the *swag* condition, see Table 1. We did a one-tailed, paired-samples t-test (n=12). On average, the ratio of runners approaching the tagger was significantly higher in the *swag* condition ($M = 0.23, SE = 0.03$) when compared to the *baseline* condition ($M = 0.14, SE = 0.04$) $t(11) = 7.90$, $p < 0.001$, $r = 0.92$. We again bundled together the data of all the runners, now regarding their movement orientation, and placed them in a rose plot. This also shows that in the swag condition runners indeed moved towards the tagger more often, see Figure 9. This can be seen by looking at the angles close to moving towards the tagger (<60°), for these angles there is a clear increase in the occurrence rates in the *swag* condition (pink bars) compared to the *baseline* condition (cyan bars). These results lead us to accept Hypothesis 2.

Towards Player Based Distance Differences

For both hypotheses we used results based on the group level, and only visualized a summation of all the individual players to clearly show the two conditions in one image for visual inspection. For our main outcome regarding proxemics, the analysis of distances included in Hypothesis 1, we used group based averages for statistical tests, because results per player are not independent and switches of tracks between and during games would invalidate within-subject comparisons. So although we found significant effects in the sessions this can either be due to most of the players changing their behavior a little or some players changing their behavior quite a lot.

We did a one-tailed, paired-sample t-test (n=48). Where we also saw a significant effect. The x-th closest runners (within-subject approximation taking into account tracker switches) in the *swag* condition ($M = 2.42, SE = 0.22$), is on average, significantly closer to the tagger, than in the *baseline* condition ($M = 2.56, SE = 0.23$), $t(47) = 5.75$, $p < 0.001$, $r = 0.86$. The means were similar to those found when we averaged over the sessions but differed slightly as the number of frames per session were not constant.

The results do indicate that it is probably not one player per session that comes closer a lot but more likely most of the players (in total 37 out of 48) coming a little closer.

[1] Effect size for this t-test was calculated with $r = \sqrt{\frac{t^2}{t^2+df}} = .78$, which was above the .5 benchmark [5]

Table 3. Average number of frames per tag for each session, both for the baseline (b) and swag (s) condition.

#	1	2	3	4	5	6	7	8	9	10	11	12
b	84	86	95	68	74	110	78	86	87	91	79	85
s	54	65	54	77	83	76	68	83	105	83	64	97
b-s	31	21	41	-9	-9	33	10	4	-19	8	16	-11

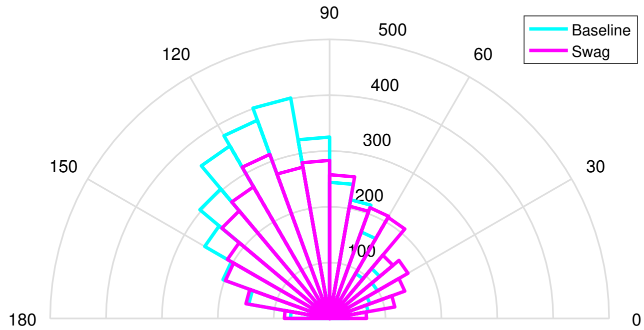

Figure 9. Movement direction of runners with regard to the position of the tagger. The angle with respect to the tagger's position ranges from 0 degrees (towards the tagger), to 180 degrees (away from the tagger). The occurrences are in number of frame segments (corrected for difference in number of frames per condition by normalization), shown in the spread direction of the graph.

DISCUSSION

Using an Enticing Steering Strategy

The results demonstrate that steering behavior can be done with an enticing strategy. The combination of collecting items rewarded with merely changing the color and appearance of a shape, can be enough to persuade children to change their in-game play behavior. We demonstrated a significant difference in proxemics, a relevant dimension in play. One might view the absolute distance as only a small effect (14cm) but if we also take into account the direction in which the children ran we can conclude that we managed to steer behavior.

This change of physical play behavior had no positive outcome for the players' primary goal of the tag game itself. Moreover, coming close to the tagger could even have a detrimental effect in regards to the primary goal of the game, as coming closer to the tagger would increase the chance of getting tagged. See Table 3 where we show the number of frames a player remained a tagger on average. If we wanted to focus on such risk taking behavior directly, the particles should have probably been placed only in front of the tagger, as that makes the risk of getting tagged bigger. When developing game mechanics to steer behavior it is important to always keep the aim, the mechanic, and the measurement aligned.

Related work has indicated that embedding game rules that *require* or *insist* a change in the behavior of players is an effective approach to change this behavior [11, 18, 35]. In this study on the other hand, we have changed in-game behavior in the form of proxemics more indirectly in an *enticing* way.

Due to the nature of the game mechanic we implemented, players might see the gathering of particles as a challenge in and of itself. However, children's utterances made during game were mostly directed towards the embellishment of the circle rather than the collection of particles. Therefore, the role of an embellishing reward may warrant further study. One way to do this, would be by adding a variation where players can collect particles but do no receive a reward for collecting the particles, i.e. no sounds and no change to the appearance of the circles. To see to what extend this would work, this non-embellished version can then be compared to both a baseline version without collecting particles, and to a version in which collection is rewarded with embellishments.

The responses of children from both the study and the sessions in the art gallery, suggest that (upon collection of objects) adding embellishments to our tag game resulted in a variation of our game that was preferred over the baseline version. It would be interesting to use a similar study to test if the embellishments of the circle's itself improve the experience of playing.

The rewards and collection of particles, also introduce a secondary goal. In a game with such a secondary goal the children can decide themselves how important such a goal is. We think it would also be interesting to see how an enticing strategy for steering behavior would work in a more open-ended play setting with no main game-outcomes to begin with.

As an enticing strategy of steering does not need to be part of the main goal, it does become easier to apply the same steering mechanisms in other contexts. In the reported study, the steering mechanism affected the difficulty of the game, and was still intertwined with the tagging mechanics as the circles were lost once tagged. The motivation for this design choice was to maintain tagging as the primary interaction. We plan to continue exploring this strategy in more games, and in this context also experiment with forms of enticement that exist in parallel with and are fully independent of the core mechanics. This application in another game would not only demonstrate the applicability of an *enticing* strategy of steering but also demonstrate its proposed added value of transferability.

CONCLUSION

An *enticing* way to steer can be used to steer behavior during play, presenting an alternative to the more often used functional rewards. In this *enticing* way of steering, actions lead (at most) to 'non-functional' rewards that are not closely linked to the core game goals. As a possible application of this strategy we steered proxemics of children playing a game in an Interactive Tag Playground. We found a significant effect on proxemics in the wanted direction: runners got closer to the tagger on average, and the runners moved towards the tagger more often. This demonstrated that this intervention, as an example of a more *enticing* way of steering, worked in our interactive playground.

The *enticing* way of steering can be a subtle way of steering. It makes it easier to investigate steering with (adaptive) interventions, as the interventions do not have to be strongly linked to main game rules but can be of an aesthetic (non-functional) nature. This should make it easier to transfer these interventions to other playgrounds and allows us to switch them on and off at will. This alternative way of steering can be a beautiful and useful way to steer play behavior in interactive playgrounds.

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