Sneaky Were-Bees: Dynamics of an Augmented Dodgeball Game Played In The Dark

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Predatory team games, such as dodgeball, have been played for centuries. This paper investigates what happens when such a game is augmented with motion sensitive lighting wearables and played in a dark environment. Looking at earlier adaptations of games as well as at the capabilities of the human body and the dynamics of predatory games we developed a new game, 'Sneaky Were-Bees', to explore the possible effects of a motion sensitive lighting wearable on the dynamics in a predatory team game. Through continuous playtesting the rules for the game, and functionality of the wearables were iteratively developed. In playtesting many interesting dynamics emerged in relation to how players attempted to identify and communicate with team members. Moreover, an in the dark predatory game seems to be much less dependent on physical prowess and more strategy based than un-augmented, traditional dodgeball. Altering a game this way sheds a new light on team dynamics and the ways a game such as dodgeball is played. These explorations are hoped to contribute to other attempts to understand the potential of adding digital technology to physical games and increasing the physicality of immersive digital experiencers.

Collaborative Games. Digital-Physical Play. Digital-Bodily Play. Embodied Interaction. Wearable Games.

1. INTRODUCTION

Darkness is a wonderful setting, as it can act as a blank canvas for beautiful things to emerge, making it a great environment for all kinds of social games, both traditional and digital-physical. Darkness provides freedom and disinhibition to players and can act as a way of balancing between physical and cognitive skills once it interferes with the dynamics of the games, as body movements in the dark become slower and more methodical (Vongasthorn et al. 2013). Low-light conditions offer an intriguing setting for creative HCI explorations as visual perception can be much less dominant in comparison with much other user experience design. However, interactive lighting effects in a darkened setting can be extremely salient, and so low-light conditions can also provide a rapid approximation of digital immersive experiences.

Our particular interest in dodgeball emerged from an intense period of playful experimentation exploring the potential impact of darkness and interactive light could have as an engaging social element. This included play-testing improvised variations of many different playground and parlour games. These included games based on speed and agility as well as ones based on tactics and creativity. Most of the play was based on games often played during childhood, and as the researchers come from different cultures, many different types of games were involved. These games were then adjusted to the dark and to best assess the dynamics. Important angles were how the dark would change communication during social play, but singular play was also considered where the interaction with the spectators was investigated.

Dodgeball is a team sport in which players throw balls aiming to hit the bodies of opposing team members, whilst avoiding i.e. *dodging* the balls that the opposing team throw at them. It is played around the world casually and also formally in schools and organised competitions with a wide variation in terms of rules, number of players, and the quantity and type of balls used. However, one common denominator is that play is contained within a clearly

demarcated playing area, such as the painted lines of a volleyball or basketball court.

Dodgeball style games feature a rapid switch in player mode between hunting and being hunted, and these contrasting states seemed very suitable as a basis for exploring contrasts in vision and visibility that interactive lighting can provide.

This led to our research aim of understanding the potential impact of wearables with a movement based light source might have on dynamics of a game played in the dark. For instance how might digital lighting effects motivate players to keep moving, and what player strategies can be identified regarding their concerns such as awareness of their surroundings, other players, and the location of the ball.

After presenting related work, and the iterative development of our experiments, we discuss and analyse the participants insights of playing a predatory game in the dark and how it affected their overall experience.

2. RELATED WORK

Coherent with our interest in exertion games and games played in dark environments, we draw upon work analysing dodgeball dynamics, darkness and the effect it can have on social and exertion games, and the human body's reactions to dark environments.

2.1 The predatory nature of dodgeball

The origins of dodgeball are African, and it used to be a deadly game, as instead of throwing balls, the participants would throw rocks or other very hard objects at their competitors, with the goal of incapacitating an opponent. It was also seen as a way of encouraging tribes to work together, learning to target the weaker opponents and protect their own (Bile 2019).

It is a game well-known for being a prey-predator kind of play experience i.e. a game in which participants dynamically alternated between hunting and being hunted. Thus dodgeball tends to reward physical abilities such as strength, agility, and speed required to cope with the need of hitting the opposition and avoid being hit (Ruth and Restepro 2020).

2.2 Prison dodgeball

There are multiple variants of dodgeball, however the one we focus on the most is what is often called *prison dodgeball* (Ruth and Restrepo 2020), which is a version where two teams of a predetermined number of players play dodgeball in a field with four

different areas, two for each team. The field of each team is composed by the prison, where the players who got hit or the players who threw a ball at the opposition and this was caught go to and are in time-out, and the playable area, which is where the players that are still in the game are. The playable areas of both teams are adjacent to each other, allowing them to throw balls at the opposition team. The players in these areas can release their teammates from jail into the playable area by throwing a ball to a jailed player and the ball being grabbed by the aforementioned player. According to Ruth and Restrepo (ibid) the outcome of a game, as well as its dynamics, are deeply influenced by a combination of the "randomness" of individual players actions and the stability of the dynamical system.

2.3 Balancing Dodgeball

Being a game based on physical prowess, the skill levels of players occasionally vary based on physical ability. This skill gap in dodgeball has led several researchers to look for ways to include different skills other than physical and turn the game a more strategical one. For instance, taking the core idea of dodgeball and digitally augmented it via wearable computing to balance players skills (Kadri et al. 2017, Nojima et al. 2015).

2.4 Seeing in the dark?

It is impossible for humans see anything in absolute darkness. When talking about absolute darkness, we are talking about the complete absence of light, which is the element that triggers a biological response in our eyes. However, it is very uncommon to be in a circumstance with absolute darkness, even at night, as the light pollution, the moon, the stars, or the natural glow of the night sky itself provide even the slightest amount of light. The majority of experiences human beings have with dark environments are cases of fragmental darkness. Which mean that, with enough time our eyes start to adapt to the environment.

According to Rosenfield and Logan (2009) in an optometry publication, human eyes require a few hours to completely adjust to darkness and reach the optimal sensitivity to low light settings. During the first minutes the eyes manage to gain significant sensibility, leading some people to think that a few minutes are enough to fully adapt to darkness, however, even after a few hours of exposure, the human eyes are still adapting and becoming more sensible to the environment. This significant initial increase in sensitivity might affect visibility during the game in case of light pollution.

2.5 Play and restricted capabilities

Low-light conditions can thought of as a restriction on normal human capabilities in play. According to Matjeka et al. (2020) there are three types of restraints that can affect the game mechanics, such as, excluding specific parts of the players' body, fixating one or some of those parts, or depriving or manipulating some of the players' senses. By using a dark environment as the playing field, we are focusing on the last type of restraint, which Matejeka et al. state that it, either temporarily or deliberately, interferes with the player's freedom of movements. In a related vein, Muller et al. (2013), presents 4 strategies to design experiences with limited control over the body, Namely, supporting players in exploring limited bodily control, supporting players upon their feelings about these restrictions, supporting players to increase their control over the body and support players in accepting and embracing the limitations imposed. Darkened conditions can have an impact on the comfort of, and likelihood of players altering their normal understandings of interpersonal space. Thus advice concerning proxemics and digital-physical play is insightful. Principally the importance of supporting exploration and discovery of proxemics zones' borderlines, and the most important, facilitating player's awareness of the zones (Muller et al. 2014).

Several existing games point to better explaining the role the lack of visual stimuli can have in predatory games (Finnegan et al., 2014, Tiab et al. 2016), the possible balancing effect light that dynamic lighting can offer games played in the dark (Worm et al. 2019), and the benefits of interdependency between players in collaborative games (Abe and Isbister 2016) or even how augmented wearables can play a big role in shifting the dynamics and physical dependency of dodgeball specifically, democratizing the game (Nojima et al. 2015). However, we have yet to see an investigation of wearable lighting and dodgeball for play in low-light conditions.

3. ITERATIVE DESIGN DEVELOPMENT

Emerging from our explorations of playing dodgeball in the dark was the identification of the importance of multi-player and competitive play. So in the next phase we focused in variations of team games were both teams want to "jail" the people from the other team by hitting them with a ball. When a player is hit by the ball, they must go to the zone in the room designated to be a jail. Team members can then release each other by spending a certain amount of time at the releasing area. As this all occurs in the dark everyone is to wear some kind of device with a possibility to increase both their vision and their visibility.

3.1 Wearable design

When designing the wearable multiple factors were considered. For technological factors, the "trigger" to turn on the lights, the amount of light, the duration of the light as well as the different behavior when the wearer is in the jail had to be considered. A basic element of the game, movement and specifically lack thereof, was taken as a trigger, making it so that it becomes a more conscious action. The amount of light was chosen to try to make the wearer visible as well as light up the immediate surroundings as to give it the properties of a search light as well. The duration was found through testing, while initially it would remain on for a set amount of time after being triggered, the final version would remain on until the wearer would start moving again. Then as lack of movement was taken to be the trigger, and the participants in jail tend to stand still, a signal was built in to block triggers to the wearable when people are in their matching jails.

Figure 1: Sketch of the motion sensitive lighting wearable illuminating as the wearer stops moving

The location of the wearable on the body as well as the aesthetics of the wearable were the physical factors taken into consideration. In-team play-tests showed the best placement of the wearable would be on the lower leg, this way covering up the device did not seem worthwhile to the participants, walking and running was the most natural way to keep the device moving and it enticed the participants to aim lower limiting the number of throws aimed at someone's head (figures 1 & 2). Besides, placing it on the leg was experienced as the least restrictive considering movement. The other physical factor, visual properties, was decided on based upon it not interfering with the visibility of the wearer. Testing showed it must be made of non-reflective materials to not alert others to the wearer's position unintentionally.
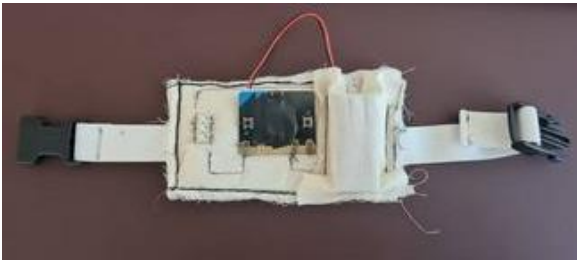
Figure 2*: One of the ankle-worn prototypes.*

Finally, to entice the teams to find their own communication formats and communication styles, and to not interfere with the team dynamics, there is no distinguishable difference between the teams based on the devices when not in jail.

3.2 Pilot testing

To explore more about the first idea created, we prepared low-fi prototypes for as motion sensitive lighting wearables to be able to play and test the game in the dark.

Participant recruitment for these tests was constrained to postgraduate students due to covid-19 building access restrictions. We recruited through our social networks. Players were of multiple nationalities with very few native English speakers and approximately equal number of male and female participants.

During the testing, we explored playing the game 1 vs 1 and 2 vs 2 to explore the different dynamics in collaborative and individual play. After conducted multiple play tests, an open feedback session was held to get insights about their experiences with the gameplay and their interaction with the prototypes. After the testing rounds, the participant's feedback about the gameplay and rules were considered, leading us to an initial concept to develop further.

3.3 Initial full-scale play test

The testing session was held in an empty and nearly dark room of circa 130m^2. Different rounds and rules were deployed for the purpose of finding the best way in which to play the game. During the session, several factors were experienced such as the number of players, duration of the light on devices, jail system, limitations on player's movement, and the number of balls in play.

Based on the size of the game area we decided to start the game with four players on each team. Before the first round begins, the rules of the game at the first round were explained to the participants, which were:

- There is a predetermined jail area for each team, as can be seen on figure 3.

- The player who gets hit by the ball goes to jail.

- To release a player from the jail one of their teammates has to stand for 8 seconds in the releasing area belonging to their team.

- Passing the ball is allowed.

- Talking is allowed.

- Adjusting the placement of the devices on the leg is allowed.

- Can be played in full court, meaning players can move all over the battlefield instead of it being divided into two halves.

The lights on devices were set up to turn on for three seconds after players did not move their legs for three seconds. Besides, to notice the players in the releasing area, the releasing area was equipped with a simple sensor system that would trigger the playing of a beep sound for eight seconds when a player is in that area.

Participants had similar profiles to those of the pilot tests and were recruited in a similar way.

3.4.1 First Round
To begin the first round, each player was assigned a team and a jail. The lights were shut down and one of the facilitators started the game by throwing the ball into the battlefield.
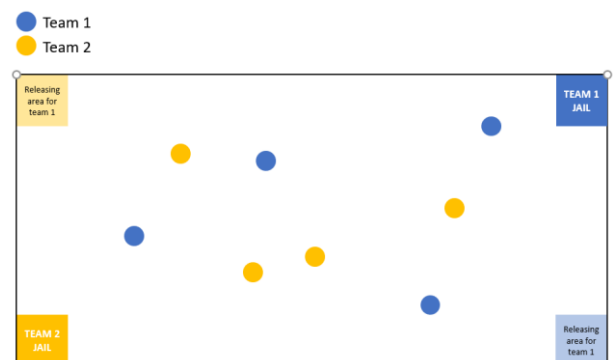

Figure 3: *This figure shows a top view scheme of the room. The yellow and blue dots stand for players and their possible starting positions. The locations for jails and releasing areas are shown.*

3.4.2 Second round
In addition to the rules of the first round, the second round had the following new rules: a) the player who owns the ball is only allowed to take one step before throwing the ball, and b) the game starts with two balls on the field.

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3.4.3   Third round

During the third round we kept the same rules however the following rule was adjusted: the player who owns the ball is only allowed to take *two steps* before throwing the ball.

3.4.4 Group interview

After the testing session was over, we conducted a semi-structured group interview in which the participants discussed their experiences with the devices, gameplay, and how they communicated with and behaved towards their fellow participants.

4. THE DESIGN: SNEAKY-WERE-BEES

Based on analysing observations and responses from the pilot tests, we named our game "Sneaky Were-Bees". "Sneaky" after the sneak properties the players thoroughly enjoyed, the shifting roles of being predator and prey. And "Were-Bees" because of losing your "stinger", the ball, after having used it against the opposition.

For the full-scale tests, the insights from the feedback of the first testing session were considered. As a result, the light duration on devices was changed from three seconds to 1.5 seconds when the players have no movement in their legs. Besides, the sound system in the releasing part was removed and instead, a way to disable the lighting function on players while they are in jail was set up.

The final testing session consisted of multiple rounds. In all rounds, both teams had to start the game against the wall on opposite sides of the field according to figure 4.
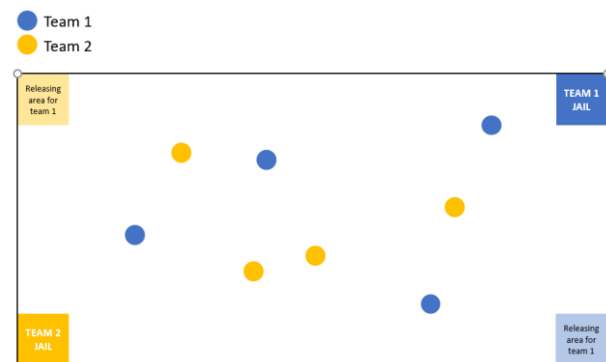

Figure 4: This figure shows a top view scheme of the room. The yellow and blue dots stand for players and their starting positions. The locations for jails and releasing areas are shown

The first round had played with two balls and two steps were allowed to be taken for whom owns the ball. The rest of the rounds had started with three balls in the field, also three steps were allowed.
One of the rounds was played in a condition that the teams had the jail and releasing area in a same side they are starting the game, as shown in figure 4.

Figure 5: This figure shows a top view scheme of the room. The yellow and blue dots stand for players and their starting positions. The locations for jails and releasing areas are shown.

5. RESULTS AND INSIGHTS

In this section we present our findings on multiple prominent features related to Sneaky Were-Bees and how the testing players acted and reacted to the environment, tools and rules. This data was collected through observations, interviews and video recordings and clustered into the following findings.

5.1 Team dynamics

An element discovered was the peer pressure that accompanied the device. By turning on the light a player would reveal their position, but they might also reveal their teammates' positions. Turning on the light to look for an opponent or the ball would sometimes be frowned upon by members of their own teams. Some teams developed a dynamic in which they would no longer use the light unless completely necessary, as they felt pressured by their team to keep it off.

5.2 Between team dynamics

One of the participants of the test convinced all the others that the facilitators were lying. With the dark setting he was able to convince others there were not as many balls in play as there actually were.
Sometimes players would get quite physical in a struggle over the ball, after a round they would question everyone to find who it was they were struggling with.

Last, in dark settings it is hard to monitor whether people are confirming to the rules when not part of the game. In the testing this seemed to be no issue, people felt the need to be honest but when someone did break the rules they were shamed by the other players and if someone had been hit with the ball due to rule-breaking it was disregarded.

During the first test one of the teams developed their own communication method by coming up with a codework, "Pineapple". By whispering this to each other they would know who was on their team and who was a member of the opposing team. However, the other team caught on after one round and starting using it to trick the pineapple team into thinking they were friendly to be able to hit them from behind. Both teams kept evolving this tactic in between rounds to try and get ahead of the other team.

The jail system provoked multiple interesting dynamics between the players of the same team as well as between the opposing teams. Within a team the players tried to attract each other's attention to either free them or to protect a player trying to free their jailed teammates. Between teams they were trying to distract opposing team members to help free their own teammates. As a system was used where players had to count aloud to 8 while standing in the release spot a distraction was a significant help to not get hit during the release.

5.3 Taking on roles

As some players were trying to be sneaky, others were more focused on acting as fast as possible. Distinct roles emerged during the game, where you had players who would just hide, others who would use stealth to infiltrate the enemy team, then people who would sneak around gathering balls to support their teammates, and people who were trying to ignore the darkness and play in high speed.

Stealth seemed to be a key factor to some players, who attempted to sneak behind and infiltrate the enemy team. On one occasion two players on the same team did so and ended up hitting each other during their ambush.

5.4 Jail awareness

In the discussion after the test participants were talking about them having to have a certain awareness. Whether they have teammates in jail they need to free, but also if there were opponents in jail that they would need to guard. By making the player who releases count aloud (whispering allowed) they could sometimes track them down

before the prisoners were released if they were on high alert.

5.5 Exploring the mechanics

As the functionally of the devices was explained without mention of the time it needed to turn it on/off the participants showed exploratory behavior, where they would risk getting hit to find out more about the workings of the device and how they could use it in their favour. Besides, restrictions seemed to be a critical part of the gameplay, limiting movement while being the carrier of the ball forced people to try and work together with their group members.

5.6 Physiological Adaptability

A prominent issue was that in longer games, people would get used to the dark and every tiny glimpse of light would cause them to be able to see the whole battlefield.

5.7 Starting position

Switching sides and starting near their own jail made the game easier according to the players and made them stay on the same side for most of the game. Having the jail opposite from where they started occasionally made them gradually switch sides as they would be jailed and then released.
Starting against the walls on opposite sides of the field made the players really stick to that side and only move within their group. They explained this behavior by referring to that side as a "comfort zone". Furthermore, crossing over to the other team had become more difficult as there was a big divide between the teams.

6. DISCUSSION

Vongsathorn et al. (2013) argues that by your movement not being visible to others, they can be performed without self-consciousness and social judgment. This relates to Sneaky Were-Bees as players were seen to try and keep the environment dark by not activating their lights as well as pressuring their team members to do the same as they felt more comfortable in the dark.

Another important thing to note is that the game was in fact quite hectic and wild. Participants expressed their enthusiasm about the game and went in fully prepared to "kill a man" to win. This made the game quite high pace, caused the teams to mingle more but also made it harder to catch all the dynamics occurring during the testing, however the experience of Sneaky Were-Bees was very much enjoyable and additional play sessions were requested.

6.1 Possible Applications

The practical application of Sneaky Were-Bees is wide. It can be used by companies or sport teams to improve the communicational skills of their employees/athletes, but it can also be used as a recreational game in multiple scenarios, like scouts' activities, school's weekend retreats or just a play session with a group of friends.

Besides, the research can also be learned from and used in future game design. One important finding from the research is that the starting position or the setup of the game may have direct impact on the dynamics of the game. By allowing participants to pick their own starting position and having it mixed the dynamics of the game became more chaotic which added an extra level of difficulty in identifying team members. On the other hand, by starting in a team on opposite sides of the field, it seemed a divide was created between the teams and players would no longer mix with the other team if preventable. This way they would know who was on their team as they had created their own side, and therefore did not need to create communication mechanisms. This should be kept in mind when designing for dynamics.

Another important thing to keep in mind is the effect the difficulty of the game has on communication. By not having the game make it clear who is on your side, the players are forced to develop their own ways to identify each other.

Furthermore, taking away vision also takes away communication through body language. Then the only viable ways become sound, touch, and possibly smell. If reliance on these sensory channels is not the goal, then a different mechanism has to be built into the game to allow for different forms of communication.

Lastly, the results from this paper are a combination of the effects of darkness as well as the motion sensitive lighting wearable. We recognize the effects of these two elements have their own intrinsic value and potential to be explored individually.

6.2 Limitations

The testing session was planned to be held in complete darkness, so that the only light would be the wearables on the players. As the session was held in an urban building with large windows, one of the challenges before testing was to prepare the room to be completely dark. Although the shutters behind the windows were closed and the blinds inside the room were down, a shimmer of light would still pierce into the room, which, as said before, affected visibility of players during longer game rounds. This then might have affected participant's dynamics during the game. As Rosenfield (2009) discusses, after exposure to darkness the fastest gains in visual sensitivity are made in the first few minutes, this led to players being able to visually recognize each other by their attributes because of this environmental light.

Paradoxically, the lack of complete darkness gave us as researchers more access to understanding the game's dynamics. However, to better understand movements, actions, and expressions of players in darkened settings, we would recommend using specialized video camera equipment.

Another obvious limitation is a certain lack of variety in our playtest participants. Although diverse in terms of nationality and disciplinary background, participants were homogenous in other respects such as age and being able-bodied.

6.3 Future Work

Perhaps the most exciting and valuable way for us to build on this study is by considering if, and how, our design ideas and insights could be applied to create better game experiences for differently-abled players. By differently-abled here we mean all sorts of conditions that may impact on player's performance whose enjoyment of physical play is normally reduced or prevented by their body consciousness concerns. Building upon the many ways offered by computer games for varying difficulty levels for players (Hunicke 2005), designers of digital-physical sports and playground games have explored balancing difficulty levels between mismatched opponents. For instance, Altimira et al. (2017) offered useful distinctions between altering play styles and impeding the performance of more competent players. Worm et al (2018) proposed a wearable system to discretely provide ability-balancing mechanisms in physical games via a mechanism in which players going more points would automatically become more visible to opponents. In a similar vein Van Delden et al. (2014) used projections to increase the visibility of particular players in an interactive installation for playing tag, and in a later iteration challenged faster players to approach those chasing them by offering an additional layer of expressive gameplay.

However, what has been much less explored is the possibility of dynamically altering the visibility of players in relation to different kinds of eye conditions and visual impairments. The onset of the most common type of the eye disease glaucoma is marked first by a decrease in peripheral vision. Having such so-called "tunnel vision" has been argued to result in differences in frequency of head

movements compared to the fully sighted (Hassan et al. 2005). Exploiting this difference could result in new opportunities to improve playful experiences for those with glaucoma. The frequency of, and direction, of head movements, is relatively easy to detect with wearable sensors, and although the direction in which a person's face points is not a guarantee of where they direct their visual attention, it frequently correlates, and has been found a simple but effective way to indicate pointing (Al-Rahayfeh and Faezipour 2013).

Thus, a combination of head position and interactive lighting may offer some discrete but intriguing means for those with glaucoma to play more equitably with the normally sighted, not only in augmented dodgeball but potentially many other physically active games. Of course, this is rather speculative - especially for multi-player and group experiencers because the possible impact of intrateam, and inter-team dynamics is very hard to understand without further empirical work.

7. CONCLUSION

In this paper, we investigated the effects a dark environment can have in predatory games, such as dodgeball. From our observations during the tests, we found that teams started to develop tactics to try to get advantage over the opposition, either by adopting a code name to identify friendly players or by using the adversaries code name to lure the other team and then hit them.

The use of a wearable with a light source also played a big part on the dynamics of the game, as within teams there seemed strong peer pressure to not turn the light on unless it was absolutely necessary as it could give up the teams' positioning to the opposition.

Besides forcing the teams to develop communicational tactics, the dark environment also allowed more adventurous and risk-taking players to try to infiltrate into the other team's core looking for some sort of opportunity that would allow them to eliminate the other team players more easily.

In short, the introduction of the dark environment brought a different dynamic to what is usually seen in dodgeball, as communicational skills as well as sneakiness became more important to the game than the speed and agility usually needed to play ordinary dodgeball.

The main action of dodgeball, and the one that gives the name to it, dodging, became almost impossible to perform in Sneaky Were-Bees due to the dark

setting, as well as the speed which the ball was thrown became irrelevant because of the unawareness the opposition has regarding the balls positioning. There were also some communicational differences as, opposing to ordinary dodgeball, where non-verbal communication plays a significant role to lure the opposition, in Sneaky Were-Bees, players were extremely verbal when communicating with their teammates.

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