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# Comparing a playful interactive product to watching television: an exploratory study for people with profound intellectual and multiple disabilities

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**ABSTRACT**

**Background**: New technologies could broaden activities for people with profound intellectual and multiple disabilities (PIMD). This study compared watching television with a newly-developed interactive ball.

**Method**: The ball responded with sounds, lights, and wiggling to the player's voice and movements. Five control sessions (watching television) were compared to five experimental sessions (interactive ball). Observations were evaluated with 10s-partial-interval recording focussed on indicators of alertness and affect, yielding 900 measurements/participant. Data were analysed with Nonoverlap-of-All-Pairs analyses and visual inspection.

**Results**: Four out of nine participants responded positively to the ball regarding alertness. Three of them also showed positive changes regarding affective behaviour. For three participants, responses were comparable to television sessions. Finally, responses of two participants appeared difficult to observe.

**Conclusions**: Responses to the ball varied widely, which fits the heterogeneous character of the targetgroup. Results are reasonably encouraging when it comes to the development and implications of interactive technologies for people with PIMD.

**KEYWORDS**
Technology; intellectual disability; leisure; quality of life; alertness; interactive activity

One subgroup of people with intellectual disabilities concerns people with profound intellectual and multiple disabilities (PIMD). People with PIMD have limited intellectual abilities, with developmental ages of up to 24 months, in combination with severe or profound motor impairments. Their overall physical health is fragile and additional seizure disorders and sensory impairments are often present. In most aspects of their lives, people with PIMD are highly dependent on the support and care of others (Nakken & Vlaskamp, 2007). Involving people with PIMD in a wide range of activities broadens their life experiences; parents and staff identified "development and activities" to be one of the most important domains of quality of life (Petry, Maes, & Vlaskamp, 2005). Although people with PIMD do have clear personal preferences regarding certain activities, participation is not self-evident due to their profound disabilities (Petry et al., 2005).

A broad range of activities are available for people with PIMD (e.g., physically-oriented, creative, and audio-visual activities; Cavet, 1995; Denziloe, 1994; Shivers, 2000). However, because they depend on others to access these activities, they are at serious risk of being faced with relatively empty schedules (Vlaskamp, Hiemstra, Wiersma, & Zijlstra, 2007; Zijlstra & Vlaskamp, 2005). In addition, activities frequently involve groups, which might not optimally fit individual preferences (Vlaskamp et al., 2007). Activities that stimulate psychomotor activity are particularly preferred (Van der Putten, Bossink, Frans, Houwen, & Vlaskamp, 2017), yet frequently offered activities lack variety and are often passive in nature (e.g., watching television, lying on a water bed; Van der Putten & Vlaskamp, 2011).

The range of activities could be broadened by using interactive technologies (Hogg, 1995; Sivan, 2000). By "interactive" we are not referring to micro-switch technology (i.e., switching the system behaviour on and off) but to activities that respond to the player's behaviour (Caltenco, Larsen, & Hedvall, 2012). Such activities can be played individually, encourage the player's autonomy, and do not necessarily require the engagement of others. We would like to emphasise, however, that even though interactive technologies might positively contribute to empty schedules, such activities should preferably not

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replace moments of personal attention and overall engagement of people with PIMD. Nevertheless, interactive technologies can be adapted to individual preferences and, therefore, may decrease understimulation, boredom, and problem behaviour (Bradshaw et al., 2004; Jones et al., 2007; Mansell, Elliot, Beadle-Brown, Ashman, & MacDonald, 2002). Although we expect several new concepts to be developed, and there is a possibility that caregivers may offer mainstream interactive toys designed for young children and babies without disabilities, published studies focussing on individualised, interactive activities for people with PIMD are currently scarce.

We explored a newly developed interactive activity for people with PIMD. An interactive ball was made that interfaces through sounds, lights and movement and responds to voices and broad movements of the player's body and head. Exposure to the ball was compared with a control condition (watching television). Both conditions were evaluated based on video observations that recorded indicators of alertness and affective behaviour. This paper reports one of a pair of papers (also: Van Delden et al., in press) that attempt to use the new interactive concept in a small-scale study.

## Method

### Participants

Nine people with PIMD were selected (fictitious names: Marc, Susan, Joyce, Linda, Dory, Pete, George, Lisa, and Tessa) based on the criteria in Table 1. Ten participants started originally, but one participant was withdrawn because of lung problems. Three males and six females ranged in age from 24 to 62 years ($M = 50$, $SD = 11$). Individual psychologists confirmed that according to the criteria of Nakken and Vlaskamp (2007), all participants had profound intellectual disabilities (i.e., developmental age up to 24 months) combined with profound to severe motor disabilities. The majority suffered from (spastic) cerebral palsy or other forms of spasm ($n = 6$). Also, psychomotor impairment ($n = 5$), visual impairment ($n = 4$), and epilepsy ($n = 6$) were common. Eight participants received 24/7 residential support from a Dutch health-care organisation. One participant received day care from this organisation and lived at home with his family. Table 2 describes the demographic characteristics.

**Table 1.** Selection of participants – inclusion and exclusion criteria.

| Inclusion criteria | Exclusion criteria |
|---|---|
| Profound intellectual disability | Lack of balance (i.e., unable to interact with the ball) |
| Severe physical disabilities | Severe hearing impairment<br>Severe visual impairment (i.e., should be able to recognise the ball to some extent) |
| Age between 18 and 65 years | Dementia |
| Depend on intensive support regarding all aspects of daily life | Visual focus of attention, unrecognisable to third parties |
| ≥4 days present at day activities centre of the care organisation | Severe epileptic seizures, which could be triggered by responses of the interactive ball<br>Great risk for overstimulation<br>Expected significant physical and/or emotional discomfort when participating in this study |

### Design

### Design & conditions

Multiple measurements were conducted in two conditions: (1) watching television; and (2) playing with an interactive ball. An AB design was used to compare both conditions. Every participant first followed five television sessions and subsequently eight to ten ball sessions. Sessions were scheduled across four consecutive weeks and took place at the same time each day. Television sessions were conducted in the first week, followed by one week of rest. Ball sessions were scheduled in the third and fourth week.

Due to practical reasons (e.g., a staff seminar [$n = 4$]; battery charging problems [$n = 2$]; and a field trip [$n = 4$]), six participants had their last television session in the second week and/or their last ball session in the fifth week. Due to technical problems (ball defect, $n = 3$) and epileptic seizure ($n = 1$), the number of ball sessions varied from eight ($n = 1$), to nine ($n = 2$), or ten ($n = 6$) sessions. We only analysed the last five sessions of each participant. The first sessions were used for

**Table 2.** Demographic characteristics of participants.

| # | Name | Gender[a] | Age[b] | Medical diagnoses and disorders[c] |
|---|---|---|---|---|
| 1 | Marc | M | 62 | Cerebral palsy, psychomotor retardation, visual impairment, epilepsy[d] |
| 2 | Susan | F | 48 | Cerebral palsy, Angelman syndrome, psychomotor retardation, epilepsy |
| 3 | Joyce | F | 52 | Cerebral palsy, psychomotor retardation, microcephaly, visual impairment, epilepsy |
| 4 | Linda | F | 47 | Psychomotor retardation, microcephaly |
| 5 | Dory | F | 48 | Cerebral palsy, psychomotor retardation, visual impairment, epilepsy |
| 6 | Pete | M | 24 | Spasm, visual impairment, epilepsy |
| 7 | George | M | 57 | Epilepsy |
| 8 | Lisa | F | 59 | Spasm |
| 9 | Tessa | F | 56 | Epilepsy |

[a]M = male, F = female.
[b]Age in years.
[c]All participants were diagnosed with profound intellectual disabilities.
[d]People with PIMD risk the occurrence of epileptic seizures (Nakken & Vlaskamp, 2007).
Note: *To guarantee health conditions of participants, participants of whom the facilitating authors together with the medical and care staff anticipated a potentially negative effect of the ball were excluded (see Table 1). Epilepsy in itself was not considered an exclusion criterion.* All names are fictitious.

habituation and adapting the settings of the ball to individual preferences.

### Design & individual sessions

An AB design was used. Five consecutive sessions in condition 1 (television) were compared to five consecutive sessions with condition 2 (interactive ball). Each 30-minute session on its own, was designed according to an ABA design: every 30 min session consisted of 7.5 min habituation/rest, followed by 15 min intervention (condition 1 or condition 2), and finished with 7.5 min rest. During periods of habituation/rest, the participant was in the room, but the interactive ball was hidden and turned off. The analyses of not interacting with the ball directly before (i.e., baseline) and after the intervention (i.e., return to baseline) were not included in the current analyses but presented in a second paper (Van Delden et al., in press).

### Intervention/conditions

#### Condition 1: watching television

In condition 1 (i.e., control condition), participants watched a programme that was a favourite according to daily support staff. Watching television served as the control condition because this type of activity is frequently provided and appears to play a substantial part of daily-activity schedules of people with PIMD (Van der Putten & Vlaskamp, 2011). Watching television was considered a regular activity of a passive and non-interactive nature: participants only had to sit and watch; no form of interaction was possible. During the sessions, one researcher and one staff member were instructed to be present but not to interact with the participant. In all circumstances, they were allowed to provide necessary medical support (e.g., in the case of the occurrence of epileptic seizures or coughing up phlegm).

#### Condition 2: interactive ball

In condition 2 (i.e., experimental condition), participants were given the opportunity to play with an interactive ball, the development of which was presented in an earlier paper (Van Delden et al., 2014). The ball was an interactive, body-controlled, physically present object. The surface was painted in yellow with blue figures to create a greater contrast. The ball could move to the right and to the left by means of internal motors, could produce several sounds and contained controllable LEDs in different colours. Sounds were played through standard PC speakers situated in front of the participant. The interactive ball was remotely controlled by using a laptop. Following individual adaptation, responses of the ball were standardised in an interaction protocol that described in detail how the researcher should respond to initiatives of the participant. The protocol described the actions from the participant that should trigger a reaction from the ball, as well as the response that the ball should give (for an overview of this protocol, see Van Delden et al., in press). Before data collection, we used three sessions to adapt the protocol to the individual preferences of each participant. For example, we adapted the volume of sounds for one participant as he seemed to be scared (i.e., shrug and widened eyes) by the initial volume. During ball sessions, two researchers and one staff member were present.

### Measures

#### Observation of alertness

A video observation system for alertness based on Vlaskamp, De Geeter, Huijsmans, and Smit (2003) was used. Their system discerns four alertness levels: (1) not alert; (2) alert, self-directed; (3) alert, directed at environment/non-person stimuli; and (4) alert, directed at people. We added a fifth category: (5) alert, directed at the ball/television. Vlaskamp et al. (2003) reported an inter-rater agreement ≥80% for the assessment of these alertness levels.

Similar to Vlaskamp et al. (2003), we used momentary time sampling with 10-second intervals to record alertness. After a period of rehearsal, two raters independently scored two ball sessions and one television session for every client (i.e., 20% of all sessions). The overall inter-rater agreement was measured using Cohen's kappa; an agreement of $\kappa = 0.795$ was reached. According to Krippendorff (1980), an inter-rater agreement ≥0.8 tends to be good for finding significant correlations in annotated data. However, his suggestion for this cut-off threshold comes with a caveat: the disagreement must be due to random noise. Patterns in the disagreement between raters could accidentally bolster relationships perceived in the data, leading to false results, as also shown by Reidsma and Carletta (2008) using simulated data. Krippendorff (1980) and Reidsma and Carletta (2008) all argue that it is important to investigate (patterns in) rater disagreement in more detail and consider how it might affect data use. To this end, Table 3 presents the confusion matrix of annotated alertness levels for all clients taken together. A first visual inspection suggests that the strongest class is "not alert," and the two weakest classes are "alert, self-directed" and "alert, directed at environment/non-person stimuli." The last two classes are harder to distinguish from each other. This is confirmed by a leave-one-out reliability analysis, in which Cohen's kappa is recalculated five times with each of the classes left out of the calculation once (see Table 4). According to Table 4, inter-rater

**Table 3.** confusion matrix – observation system alertness.

| | Not alert | Alert: Self-directed | Environment | Ball/TV | Person | ∑ | % |
|---|---|---|---|---|---|---|---|
| Not alert | 1335 | 80 | 2 | 2 | 0 | 1419 | 0.29 |
| Self-directed | 27 | 1406 | 128 | 42 | 10 | 1613 | 0.33 |
| Environment | 5 | 200 | 726 | 28 | 27 | 986 | 0.20 |
| Ball/TV | 0 | 38 | 64 | 302 | 9 | 413 | 0.09 |
| Person | 0 | 45 | 18 | 5 | 319 | 387 | 0.08 |
| ∑ | 1367 | 1769 | 938 | 379 | 365 | | |
| % | 0.28 | 0.37 | 0.19 | 0.08 | 0.08 | | |

Note. Po = 0.8485; Pe = 0.2592; $\kappa = 0.7955$.

reliability of alertness levels is acceptable for all classes, although the distinction between "alert, self-directed" and "alert, directed at environment/non-person stimuli" should be approached with caution in this study.

Finally, as behaviours of people with PIMD are so idiosyncratic, it is uncertain whether high average agreements carry over to the level of individual ratings. Therefore, Table 5 shows kappa scores for individual participants. Regarding alertness, the inter-rater agreement for Lisa was $k = 0.597$. Researchers' notes revealed that it was difficult to record Lisa's focus of alertness due to her type of habitual head movements. For two participants, agreement was $0.6 < k < 0.7$; the remainder of the data reached good/excellent agreement (Fleiss, 1981).

### *Observation of affective behaviour*

Due to a lack of suitable measures, we developed an observation system to assess affective behaviour and customised it for each individual client. The negative-affect scale was based on the Cohen Mansfield Agitation Inventory (CMAI) (Cohen-Mansfield, 1991; De Jonghe & Kat, 1996), which measures agitation among elderly residents. It contains 29 items in three factors: (1) aggressive behaviour; (2) physical non-aggressive behaviour (e.g., repetitive behaviour); and (3) verbal agitated behaviour (e.g., screaming) (Cohen-Mansfield, 1991; Zuidema, de Jonghe, Verhey, & Koopmans, 2007). The inter-rater reliability is well demonstrated and appeared to range from 0.88 to 0.92 (Cohen-Mansfield, 1991). The positive-affect scale was based on indices of happiness as described by Green and Reid (1996, 1999). A distinction was made between two expressions: (1) facial expressions (e.g., smiling); and (2) vocalizations (e.g., yelling while smiling). Recording was reliable and valid for people with PIMD (Favell, Realon, & Sutton, 1996; Green & Reid, 1996, 1999).

**Table 4.** Re-calculation of Cohen's Kappa – observation system alertness.

| Class | Reliability when class left out |
|---|---|
| Not alert | 0.722 |
| *Alert* | |
| self-directed | 0.916 |
| directed at environment/non-person | 0.891 |
| stimuli | 0.821 |
| directed at ball/TV | 0.800 |
| directed at people | |

Because people with PIMD often use idiosyncratic and subtle expressions depending on person and context (Hogg, Reeves, Roberts, & Mudford, 2001), Dillon and Carr (2007) recommend adapting observation systems to individual clients. Therefore, an individual registration form was developed systematically. First, we made a list of all items of the CMAI and added the observable responses generally associated with subjective feelings of happiness as defined by Green and Reid (1996, 1999). Thereupon, staff indicated which items applied to the individual client and indicated whether the individual participant showed relevant idiosyncratic behaviour (e.g., folding hands together in happy mood). This process resulted in nine unique lists of behavioural indicators.

Partial interval recording was with 10-second intervals (Favell et al., 1996; Green & Reid, 1996, 1999). More than one score for each interval was allowed because indicators could occur simultaneously (e.g., smile and negative vocalisations). After a rehearsal period, both raters independently scored 20% of all sessions to determine inter-rater agreement. To compute Cohen's kappa, indicators for negative affect were merged into one class, as were indicators for positive affect. Based on Krippendorff's (1980) threshold of 0.8, the inter-rater agreement was considered good enough for further analysis for both positive affect ($\kappa = 0.91$)

**Table 5.** Cohen's Kappa at the level of individual participants.

| Participant | Kappa: Alertness | Positive affect | Negative affect |
|---|---|---|---|
| Marc | 0.733 | 0.387[a] | 0.793 |
| Susan | 0.741 | n.c.[b] | 0.857 |
| Joyce | 0.612 | 0.755 | 0.793 |
| Linda | 0.786 | 0.796 | 0.922 |
| Dory | 0.930 | n.c. | n.c. |
| Pete | 0.750 | n.c. | 0.874 |
| George | 0.783 | n.c. | n.c. |
| Lisa | 0.597 | 0.667 | n.c. |
| Tessa | 0.626 | n.c. | n.c. |
| Tot | 0.814 | 0.787 | 0.907 |

[a]Based on a limited number of data points (<5%) in this particular category.
[b]n.c. = not calculated due to a lack of data in this particular category.

and for negative affect ($\kappa = 0.79$). Table 5 additionally shows the kappa scores for each individual participant. Ratings for client #1 (Marc) reached inter-rater agreement of $k = 0.387$ for agitation, based on a limited number of occurrences of samples for that category (<5%). For some clients, there were not enough occurrences of positive/negative affective behaviour to analyse agreement. The remainder of the data reached a satisfactory agreement.

## Procedure

The research proposal was approved by the approval from the Medical Ethical Committee Twente (study P14-08, NL48070.044.14) and the internal science advisory board of healthcare organisation Dichterbij. In consultation with service coordinators and support staff, ten participants were selected based on the inclusion and exclusion criteria (see Table 1). During a staff meeting, the researcher presented the interactive ball and information about the study. Information letters were sent to all staff members of selected participants. Staff members were requested to give their written consent. Informed consent for the participants was obtained from legal representatives based on an information letter and a written consent form. Thereafter, the procedure for customisation of the observation system started. Individually preferred timing of sessions (morning/afternoon) was also determined in consultation with support staff.

Data collection started and each participant was videotaped during both conditions. Sessions were recorded with three Panasonic HC-V520 cameras, all in front of the participant, with two placed in different corners and one in the middle. All sessions took place in the same room. Every session lasted 30 min (of which there was 15 min of intervention). Raw data were archived in accordance with guidelines from both universities. After the assessment of inter-rater agreement, the remaining sessions were divided across two raters and subsequently rated. Data were analysed using Microsoft Office Excel and IBM SPSS Statistics 22.

## Analyses

Indicators of alertness and affective behaviour were recorded for every 10-second interval, resulting in 90 ratings for each session of 15 min. We merged indicators for negative affect into one class, and those for positive affect into another. For every single session, we calculated for each alertness level, as well as for positive/negative affective behaviour, the percentage of intervals in which these had been observed.

After that, the various session percentages of condition 1 (television) were compared, per client, with those of condition 2 (interactive ball) by calculating Nonoverlap of All Pairs (NAP) (Parker & Vannest, 2009). NAP is a method of comparing pairs of data; each data point (i.e., one session percentage) in condition 1 is compared with each related data point of the same type in condition 2. Thus, for each alertness level, as well as for indicators of affective behaviour, five data points in condition 1 were compared to five data points in condition 2, resulting in 25 pairs (comparisons) per behaviour type per client.

In calculating NAP, the value of each pair is expressed in a nominal score, with three possible scores: (1) a score of zero is given when a data point in the control condition 1 is "better" than a data point in the experimental condition 2; (2) a score of 0.5 is given when a data point in condition 1 exactly equals a data point in condition 2; and (3) a score of 1 is given when a data point in condition 2 is "better" than a data point in condition 1. A final NAP score is calculated by dividing the "sum" of scores by the total number of pairs.

With this method it can be taken into account that certain behaviours should increase whereas other behaviours should decrease through the interpretation of what is considered "better" for each type of behaviour. We hypothesised that participants would focus more on the world around them, would be more alert, and would increase their amount of positive affect during ball sessions. Similarly, we hypothesised that levels of non-alertness and negative affect would decrease. The analyses were conducted in such a way that a high NAP score indicates an increase in alertness and positive affect and/or a decrease in non-alertness and negative affect.

# Results

## Alertness

### Marc, Linda, Pete, and Lisa

Table 6 presents the final NAP scores regarding alertness. Marc, Linda, Pete, and Lisa showed similar patterns of change in alertness. Based on the medium and strong effects in Table 6, their amount of being "not alert" or being "alert, self-directed" was less during ball sessions compared to television sessions. Instead, they increased their amount of being "alert, directed at the object" during sessions with the interactive ball.

The graphical presentation in Figure 1 helps to visualise and understand the more detailed meaning of these effects for each individual. The graphs show those behaviours for which NAP scores exhibited a strong effect.

**Table 6.** Nonoverlap of all pairs[a] for alertness.

| | Low alertness[b] | | High alertness[c] | | |
|---|---|---|---|---|---|
| | Not alert | Alert, self-directed | Alert, ball or TV | Alert, environment | Alert, person |
| Marc | **0.68** | 0.28 | **0.80** | 0.44 | 0.58 |
| Susan | 0.50 | 0.56 | 0.20 | 0.40 | **0.80** |
| Joyce | 0.52 | 0.48 | 0.52 | 0.40 | 0.38 |
| Linda | 0.50 | **0.74** | ***1.00*** | 0.40 | 0.12 |
| Dory | 0.08 | **0.68** | 0.04 | 0.20 | 0.50 |
| Pete | **0.78** | **0.72** | **0.82** | 0.48 | 0.30 |
| George | **0.80** | 0.20 | 0.64 | 0.60 | 0.40 |
| Lisa | 0.14 | **0.82** | **0.86** | 0.36 | 0.52 |
| Tessa | 0.36 | 0.56 | 0.36 | 0.44 | 0.38 |

[a]No formatting = 00.00–00.66 weak effects; **bold** = 00.66–00.92 medium effects; ***bold and italic*** = 00.93–1.00 large or strong effects (Parker & Vannest, 2009).
[b]Expected decrease in one-tailed NAP calculation (high NAP value means decrease in behaviour).
[c]Expected increase in one-tailed NAP calculation (high NAP value means increase in behaviour).

Marc was structurally more often "not alert" than "alert, at the object" during television sessions, whereas this pattern was the opposite during two of the five ball sessions. Linda showed a rather ambiguous pattern of being "alert, at the object" and "alertness, self-directed" during television sessions. Her pattern became much clearer during the ball sessions in which "alert, at the object" was consistently more present than "alertness, self-directed." Despite medium effects in Table 6, Figure 1 shows that Pete was relatively often "not alert" or "alert, self-directed" during both conditions. However, Pete's level of "alertness" was almost zero during television sessions and visibly higher during ball sessions. Finally, despite medium and strong effect sizes, Figure 1 shows that for Lisa the presence of "alert, self-directed" dominated the amount of "alertness at the object" in both conditions. It should be noted that Lisa was also the client for whom the inter-rater agreement on alertness was the lowest.

### *Joyce and Tessa*

Table 6 indicates that Joyce and Tessa showed no remarkable changes in their alertness levels. Values ranged between .36 and .56, which gave no motive for further graphical inspection. Indicators of alertness were relatively similar in both conditions for both participants.

### *Susan, Dory, and George*

Three participants had ambiguous and unclear low NAP results (see Table 6). To obtain an understanding, their data were visualised in Figure 2. Based on Table 6, Susan was more "alert, directed at people" during ball sessions compared to television sessions. Figure 2 shows that Susan was less focused on the ball (compared to television) and more focused on the people present in the room during ball sessions. Dory showed a mixed pattern of being alert at the television versus being "not alert" or "alert, self-directed" during television sessions. However, her pattern clearly changed during ball sessions. Dory was now more often "not alert" or "alert, self-directed," whereas, her amount of alertness at the object was almost zero. Finally, George showed a relatively consistent pattern across conditions. Most of the sessions, he was "not alert" or "alert, self-directed." Alertness at the object was limited to almost zero level. During two of the ball sessions, his amount of time being not alert was a little less in favour of being alert on account of the object. This change does not seem to represent a medium or strong effect (see Table 6).

## *Affective behaviour*

### *Susan, Linda, Pete, and Lisa*

Four participants showed medium and strong effects according to NAP values. Table 7 indicates that Susan, Linda and Pete showed more positive affect during ball sessions, whereas Lisa showed less negative affect during ball sessions compared to television sessions. To understand the meaning of these outcomes, effects are visualised in Figure 3.

Graphical data confirm that Susan showed more positive affect (both vocal and facial) during ball sessions. Compared to Susan, the expected difference in positive affect is less clear for Linda (see Figure 3). Due to the strong effect on stereotypical behaviour (see Table 7), data regarding stereotypical behaviour were additionally visualised for Linda. Despite her ambiguous change of positive affect, Linda's amount of stereotypical behaviour was visibly less when ball sessions were compared to television sessions. The graph showing Pete's affective behaviour clarifies that both positive facial and vocal expressions were more often present during ball sessions, with the biggest difference in positive facial expressions. Finally, Figure 3 shows that the expected lower amount of negative affect for Lisa seems to be caused by a single drop in her negative affect during ball session 3. Data for the other sessions do not seem to indicate visible trends.

### *Joyce, Dory, and George*

Table 7 indicates that Joyce, Dory, and George showed no remarkable changes in affective behaviour when television sessions were compared to ball sessions. Values ranged between .50 and .60, which gave no motive for further graphical inspection.

### *Marc and Tessa*

Finally, Marc and Tessa had ambiguous NAP results (see Table 7). Their NAP scores indicated the presence of

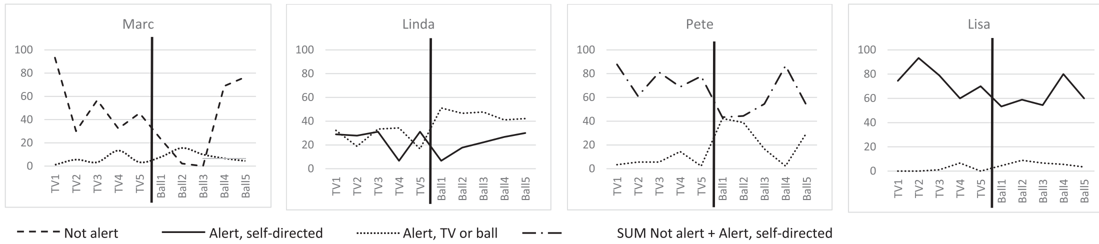


**Figure 1.** Alertness across conditions for Marc, Linda, Pete, and Lisa—mean session percentages.

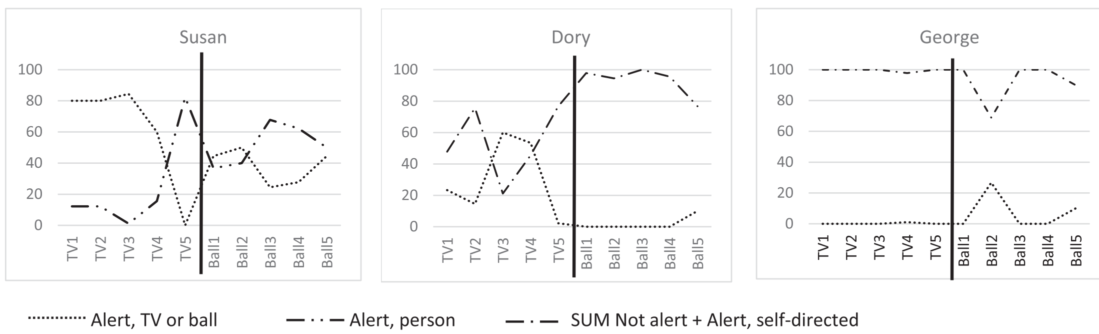


**Figure 2.** Alertness across conditions for Susan, Dory, and George—mean session percentages.

diverse, unexpected effects for positive facial and negative facial expressions (Marc) or positive facial and positive other expressions (Tessa). To gain insight into the meaning of these results, data were visualised in Figure 4.

Figure 4 clearly shows that Marc's affective behaviour was quite similar and stable across sessions and across conditions. Tessa, on the other hand, showed large differences across sessions in her amount of "other positive expression." Except in television session 4, her amount of positive facial expression was relatively stable. Based on the graphical data, a possible trend of positive affect across conditions remains unclear for Tessa.

## Discussion

In this study, we explored a newly developed interactive ball that was adapted to individual preferences and responded to voices and broad movements of the player. Exposure to the ball was compared with a control condition (television); the assessment was based on indicators of alertness and affective behaviour.

The variety of responses to the interactive ball fits the heterogeneous character of this target group (Nakken & Vlaskamp, 2007). Four out of nine participants clearly responded positively to the ball, based on alertness levels.

**Table 7.** Nonoverlap of all pairs[a] for affective behaviour.

| | Negative affective behaviour[b] | | | Positive affective behaviour[c] | | |
|---|---|---|---|---|---|---|
| | Facial expression | Vocalisation | Stereotypies | Facial expression | Vocalisation | Other |
| Marc | 0.20 | 0.40 | – | 0.30 | 0.60 | – |
| Susan | – | 0.50 | – | ***1.00*** | ***1.00*** | – |
| Joyce | 0.50 | 0.50 | 0.46[d]; 0.44[e]; 0.34[f] | 0.52 | – | – |
| Linda | – | 0.50 | ***0.94***[g] | **0.90** | ***1.00*** | – |
| Dory | 0.60 | 0.50 | – | 0.50 | 0.50 | – |
| Pete | 0.54 | 0.50 | – | ***0.96*** | **0.88** | – |
| George | 0.50 | 0.50 | – | 0.50 | 0.50 | – |
| Lisa | **0.76** | 0.50 | – | 0.50 | 0.50 | – |
| Tessa | 0.50 | 0.50 | 0.52[i] | 0.36 | 0.50 | 0.28[h] |

[a]No formatting = 00.00–00.60 weak effect; **bold** = 00.66–00.92 medium effect; ***bold and italic*** = 00.93–1.00 strong effect (Parker & Vannest, 2009).
[b]Expected decrease in one-tailed NAP calculation (high NAP value means decrease of behaviour).
[c]Expected increase in one-tailed NAP calculation (high NAP value means increase of behaviour).
[d]Moving tongue in mouth.
[e]Stereotypical vocalisation.
[f]Rubbing hands.
[g]Body rocking.
[h]Folding hands together.
[i]Sigh and turn head.

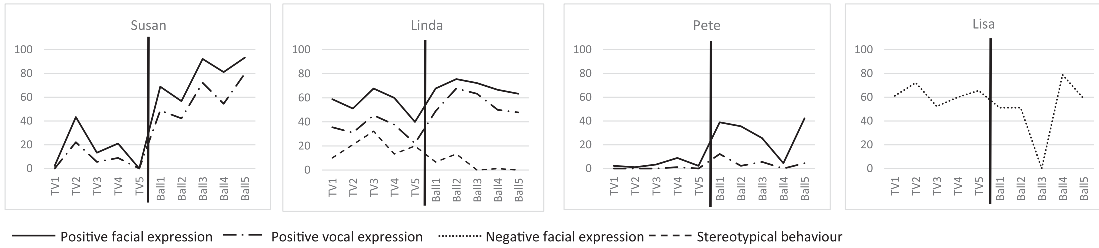


**Figure 3.** Affective behaviour across conditions for Susan, Linda, Pete, and Lisa—mean session percentages.

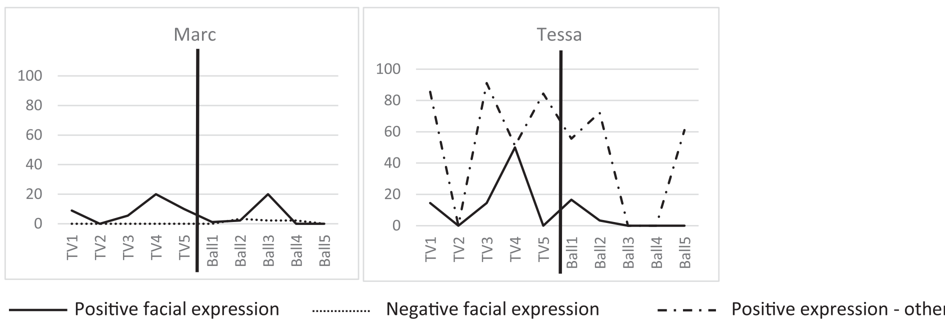


**Figure 4.** Affective behaviour across conditions for Marc and Tessa—mean session percentages.

In addition, three of them showed positive changes in affective behaviour as well. For three participants, alertness and affective behaviour were comparable to television sessions. Finally, one participant fell asleep during ball sessions and the responses of one participant were difficult to observe from the video data and seemed to show no changes. Data might seem ambiguous, but they provide reasonably positive expectations. It would be unrealistic to expect similar behavioural responses for a group of participants that vary so widely in their possibilities to be aware of and respond to their environment (Petry et al., 2005). The present results might be encouraging when it comes to the use of interactive technologies for people with PIMD. The first impression is that the interactive ball seemed to have quite a positive impact on affective behaviour and alertness for almost half of the participants, which deserves further consideration for development and implications.

Apart from recognising the heterogeneous character of people with PIMD, the present results also contribute to the debate of scientific assessment in the field of PIMD. People with PIMD and their caregivers are confronted with severe intellectual and motor disabilities. In most cases, caregivers and researchers cannot rely on their usual (linguistic, cognitive) means of communication (Hendriks, 2012). It is very difficult to reliably assess (verbal) self-reports/subjective experiences that are related to one's quality of life (Selai & Rosser, 1993). Instead, researchers have to rely on proxy reports or standardised observation systems to look for subtle changes in non-verbal communication (Golden & Reese, 1996; Goode & Hogg, 1994; Lancioni, Singh, O'Reilly, Oliva, & Basili, 2005; Maes, Lambrechts, Hostyn, & Petry, 2007; Munde, Vlaskamp, Ruijssenaars, & Nakken, 2009). Despite the use of systematic and careful observation, such assessments will always leave the researchers with some degree of uncertainty. Lisa, for example, was difficult to observe because she continuously moved her head and frequently blinked. As a consequence, the reliability of our systematic observations decreased and possible changes in alertness and affective behaviour remained unclear. How did she experience both conditions? Did she notice the ball in the room and did she like it? And Susan in another way, showed an increase in positive affect and focused more on people in the room when ball sessions were compared to television sessions. She clearly liked something during these sessions, but what is the meaning of her looking at the people in the room? Did she like the ball sessions and shared her excitement with the people around her? Or was she distracted by the people in the room and had fun with/about them? Such uncertainties force us to carefully interpret research findings and continue to consider the use of alternative measures (e.g., biomarkers) that might give more information about the internal arousal and experiences of people with PIMD (Vos et al., 2012).

Some limitations should be mentioned. First, this exploratory study concerned only nine participants.

Still, it is worth sharing because each graph was based on a rich database of 900 measurements (i.e., 2 conditions × 5 sessions × 90 ratings). Second, participants had two/three habituation sessions only and were consequently observed during five ball sessions. It would have been worth assessing long-term exposure to the ball. Third, our design could be improved by including a return-to-baseline condition. This would mean that participants would again – after four weeks of participation – be exposed to one week of rest and a subsequent week of television sessions. In this study, authors were not sure whether the additional burdening of participants would outweigh the scientific benefits of the design. On the other hand, within sessions we used an ABA design and analysed the impact of introducing and removing the ball (see Van Delden et al., in press). Fourth, the ball could not operate completely independently of manual control. To decrease the impact of subjective response patterns, we used a protocol that standardised the responses of the controller to decrease possible bias. Fifth, although the majority of observation scales appeared to have acceptable to good inter-rater agreement, detailed inspection revealed that the distinction between "alert, self-directed" and "alert, directed at environment/non-person stimuli" should be approached with care in this study. Fortunately, the present analyses did not, however, require us to distinguish both subscales. Finally, the use of NAP, which is based on one-way testing, is debatable in an exploratory study. The NAP is sensitive for expected increases that result in strong effects (Parker & Vannest, 2009). The NAP is not sensitive in distinguishing "no changes in patterns" from "unexpected decreases in patterns." We added visual inspection because we believe that combining these analyses contributed to an in-depth understanding of the data.

This study might stimulate professionals' awareness of future possibilities in newly developed activities for people with PIMD. Through such innovation, boring and empty schedules and lack of psychomotor activities might be reduced. In addition, interactive technologies can be adapted to personal preferences. Although a person-centred design is not a guarantee, it will increase the attractiveness of the product and arouse the player's interest. Person-centred development invites caregivers to consciously think about the type of stimuli that would be preferred, might enrich the person's series of leisure activities and, therefore, might evoke an autonomy-stimulating attitude in caregivers. Finally, this study contributes to the increase of evidence-based interventions in the field of PIMD. New technologies offer many new possibilities, but we should be careful in adopting them without considering a new technology really works, how and when it works, and for whom. Small pilot studies may contribute to in-depth knowledge about the impact of activities at a personal level (Yin, 2003).

It would be worth developing and investigating improved versions of the interactive ball. A 2.0-version of the ball should be able to respond automatically and could be the subject of replication studies with larger samples and longer periods of measurement. Indicators of effect could be maintained and possibly extended with biofeedback measures (e.g., skin resistance) and the assessment of body movement as indicators of internal arousal. Also, studies with alternative target groups (e.g., individuals/groups of individuals with dementia) might be worth conducting. As the interactive ball could be adapted to individual preferences, not only individuals with PIMD, but all individuals with similar ways of enjoying interactive play might be interested. Finally, it is recommended to increase the use of extended inter-rater agreement analyses in the field of ID research.

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