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RESEARCH-ARTICLE

User Experience, Attitude towards Replay and Play Endings – a semi-Situated Study of an Interactive Play Space

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Figure 1: Person Playing with the Interactive Play Space

Abstract

Interactive Play Spaces can support positive behaviour. Play endings, user experience (UX), and replay intention, can play an important role to achieve this. However, the relation between these aspects is underexplored. We explore how different types of endings—*open*, *closed positive (winning)*, and *closed negative (losing)*—affect user experience and attitude towards replay in a semi-situated study with 93 adults in a science center. While assigned ending conditions did not significantly influence reported experience, many participants, significantly in the open-ended condition, *perceived*

their assigned ending condition differently. Analysis on these *self-reported* endings revealed that players who experienced a closed negative ending reported higher *Stimulation (UEQ)*. Additionally, user experience dimensions (*Attractiveness*, *Dependability*, *Stimulation*) and *Positive Affect (I-PANAS-SF)* positively related to *attitude towards replay*. These findings provide insights into the relation between play endings, UX and attitude towards replay, and highlight the importance of inquiring about experienced experimental conditions in user research.

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CCS Concepts

• **Human-centered computing** → Human computer interaction (HCI); HCI theory, concepts and models;; Interaction design; Interaction design process and methods; User interface design;; Human computer interaction (HCI); HCI design and evaluation methods; User studies;; Human computer interaction (HCI); Empirical studies in HCI.

Keywords

User Experience, UX, Museum Exhibit, Interactive Installation, Interactive Play Space, Play Endings, Goal Setting, Open Ended, Closed Ended, Replay, UEQ, PANAS, Exergame, Embodied Interaction

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1 Introduction

Interactive Play Spaces (IPS) (aka. Augmented Play Spaces [13, 42]) are physical spaces that are enhanced with playful interactive technology [13]. IPS can take various forms, such as interactive playgrounds [74, 75], interactive exhibits [40] and exertion interfaces [50]. They have the potential to support and evoke positive behavior, such as social interaction [35] and exercising [7, 50]. Furthermore, they can also support cognitive development [37].

For IPS, especially in the case where they support positive behavior, it is beneficial when they are used repeatedly [46]. Therefore, it is important to understand how design features of IPS contribute to a positive attitude towards replay.

To facilitate replay, it is important that people have a positive remembered experience after playing [72]. A positive experience is influenced by the affective experience on specific moments, in particular at its ending [18]. This is also known as the *peak end rule* [8, 20, 26, 27].

Endings in IPS can be designed in various forms. Endings can be *open* [68], where the game gives no indication when play ends and the player decides when to stop playing. Or they can be *closed*, where there is a clear designed ending, such as being 'game over' – *losing* – after too many faulty actions, or – *winning* – by achieving the play objective after a series of correct actions. Previous research indicates that positive user experiences relate to a positive attitude towards replay, and that endings are important in evoking positive user experience. As a result, endings could potentially influence the attitude of a player towards replay. Despite their potential importance, endings, and their influence on user experience is currently still an underexposed and undervalued topic in the domain of Human-Computer Interaction (HCI) [8, 20, 36, 39, 42].

Through our study we want to contribute to a better understanding of the relation between play endings, user experience and attitude towards replay for IPS. We aim to achieve this by focusing on the following research questions:

- How do different endings affect user experience of IPS?
- What is the relation between user experience and attitude towards replay in IPS?
- How do different endings affect attitude towards replay of IPS?

We conducted an experimental study in the semi-situated context of a science center with actual visitors as participants, closely resembling real-world conditions and context. Players played with a movement-based playful interactive exhibit in one of three, randomly assigned ending conditions: *open*, *closed positive (winning)*

and *closed negative (losing)* and completed a questionnaire about *user experience* (UEQ & I-PANAS-SF) and *attitude towards replay* afterwards.

We provide insights into the design of engaging interactive play experiences that encourage repeated participation, hereby supporting achievement of their intended objectives. Our findings contribute to the domain of user experience and interaction design, by providing insights into the relation between play endings, UX and attitude towards replay. Furthermore, our findings highlight the importance of inquiring about experienced experimental conditions in user research.

2 Background & Related Research

In this section we present relevant background and related work for our research. We first introduce the concept of user experience (UX) and different perspectives [51, 52] on user experience. This is followed by how experiences are remembered and how expectations towards experiences are influenced. We end this section with background about play endings and their relation to UX.

2.1 User Experience

In the past, the concept of user experience (UX) design has often been explained as the mere usability of a product. [1, 32]. Nowadays, UX has evolved into a more detailed concept that includes emotional and temporal aspects of experience [32, 52] (third wave of Human-Computer Interaction (HCI) [52]). The International Organization for Standardization (ISO) currently defines user experience as: “A person’s perceptions and responses that result from the use or anticipated use of a product, system or service.” [62].

2.1.1 Perspectives on UX. User experiences (UX) can be distinguished into different types: *Pragmatic*, *Hedonic* [28], and *Eudaimonic* [11, 43].

Pragmatic UX focuses on functional aspects and refers to how a user perceives the capability of a product to support expected usage goals. Optimal pragmatic user experience is pursued by attempting to achieve optimal sense of efficiency, effectiveness, and usability [43].

Hedonic UX focuses on users’ emotions and momentary pleasures. Hedonic UX is about facilitating an emotional connection between a user and the interface, making the interaction not just efficient but enjoyable [11].

Eudaimonic UX goes beyond individual tasks, functionality, and emotions, tapping into a deeper, more meaningful connection. This type of experience is about fulfilling a user’s potential and about contributing to their overall well-being. This goes beyond momentary pleasure, aiming for sustained satisfaction, personal growth and meaning coming from need fulfilment [43].

Pragmatic, *Hedonic* and *Eudaimonic* UX each have distinct characteristics, but are also interconnected. While they each focus on another aspect (or goal) of UX, they all contribute to overall user perception. They however have different temporal aspects. Pragmatic experiences are associated with short-term, task-focused goals. Eudaimonic experiences often are achieved over time. Hedonic experiences can be either. Eudaimonic UX is more associated with prolonged use, while pragmatic and hedonic UX are more applicable to initial interactions [28].

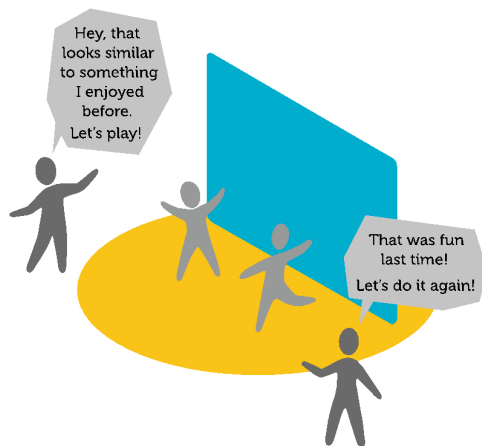


Figure 2: Previous experiences influence attitude towards similar experiences [41]

In our study we examine how players experience a single encounter with an Interactive Play Space. We therefore focus on user experience from a pragmatic and hedonic perspective, while acknowledging their importance and role to achieve eudaimonic UX in the long term. Because when good pragmatic and hedonic user experience is achieved, repeated use of a system is likely, and this will lead to these long-term effects.

2.1.2 Experience Expectations. To understand people's attitudes towards replay, it is important to understand how their expectations are formed and influenced. Research indicates that memories of previous experiences influence prejudices, expectations, and associations regarding current and future similar or recurring experiences [17, 58, 59]. And that memories of experiences are predictors of future behavioral choices [30, 72].

Episodic memory is specifically important in this context because it involves both recalling past events and imagining future ones [57]. It refers to the conscious recollection of personal experiences, including the specific details of what happened, where, and when [47]. Kahneman et al. differentiate between an experience during an event and recollection afterwards (known as 'the experiencing self' versus 'the remembering self' [26]).

Positive remembered experiences play a crucial role in shaping behavior, such as replay in our study. Therefore, an important factor contributing to the likelihood of (repeated) engagement with an Interactive Play Space is an individual's expectations, based on prior positive experience with the same or a similar system (Figure 2).

This means that if someone remembers enjoying playing with an IPS before, they are likely willing to play with it again. It is therefore particularly important that someone remembers the previous experience positively, the experience does not actually have to have been (completely) positive.

2.1.3 User Experience & Replay. Related studies have identified connections between specific user experience dimensions and (replay) intention. In a review of the overlap between the Technology Acceptance Model and User Experience, Hornbaek et al. [24], based

on an analysis of 37 papers, found that enjoyment (hedonic UX) has a significant impact on attitude. They noted that "*the effect of perceived enjoyment on attitude is stronger than those of perceived usefulness and perceived ease of use*". A study using the User Experience Questionnaire (UEQ) [12] also found that hedonic qualities predict customer intention to use social robots in retail.

Research with the Positive and Negative Affect Schedule (PANAS) indicated mixed results regarding affect and behavioral intention. For instance, Kyral et al. [31] found that both positive and negative affect were unrelated to exercise intention in college students participating in aerobic exercise. In contrast, Pelegrin-Borondo et al. [49], in a marketing study, showed that positive emotions evoked by the novelty of a new type of wine strongly predicted purchase intention, while the emotions from the winery visit had little impact. Similarly, Bae et al. [2], in a study on online gaming, found that both pleasure and arousal were key factors influencing the intention to replay games.

In a related study, Hensley [22] examined AR versus VR exergames and found no significant differences in positive or negative affect between more and less immersive conditions. Likewise, there were no significant differences in future engagement intentions between conditions. However, they did not analyze the correlation between PANAS scores and future engagement intentions.

These studies show that enjoyment and positive emotions often predict behavioral intentions, though their impact varies by context, activity type, and measurement approach. This highlights the importance of context-specific analysis when exploring the relationship between user experience and engagement intention.

2.2 Play Endings

2.2.1 Endings & Experiences. The *peak-end rule* [8, 16, 26, 41], along with the *recency effect* [48], explain how people remember experiences [19, 60]. The *peak-end rule* indicates that memories of past experiences are most strongly influenced by the emotionally most intense (positive and negative) moments (peaks) and the affective experience at the end of the experience [16, 20, 27, 63, 69] (Figure 3). The *recency effect* explains that people have better emotional memory for the end of an experience than the beginning [48]. Memory of enjoyment at the end of an experience particularly determines the desire to repeat it [18].

In the field of HCI relatively little is known about the impact of *peak-end* effects on gaming experience [36, 39] and the specific design variables that contribute to these effects [20].

A study by Cockburn et al. [9] indicated strong recency effects in interactive tasks. In another study [8] they found a significant effect of the combined manipulation of both peak and end on preference in interactive sequences. Additionally, Gutwin et al. [20] showed that manipulating the sequence of difficulty, and the challenge-skill balance in three casual screen-based games resulted in peak-end effects, influencing users' recollection of challenge and perceived fun, interest, and willingness to replay.

Because of the peak-end rule, designing with attention to important moments of a participant's journey [40, 42], with particular emphasis on the ending, results in digital products that are worth remembering [63].

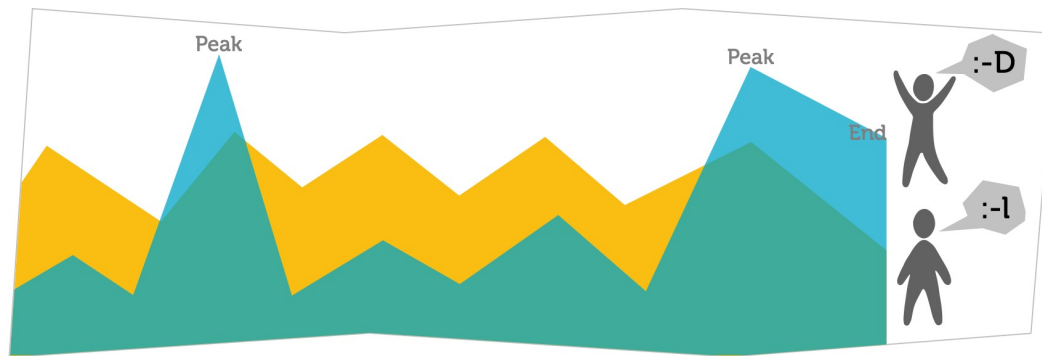


Figure 3: The peak-end rule: affective peaks and ending of an experience determine the recalled experience [41]

For an IPS, this means that it is not the entire experience that needs to be designed for optimal user experience but merely specific moments that will lead to a positive remembered experience. The ending might be the most influential. In our study, by focusing on specifically ending moments of a play experience, we hope to better understand how to design for positive user experience and increase the willingness to replay.

2.2.2 Types of Play Endings. In the previous section we emphasized the importance of endings for user experiences, and consequently attitude towards replay. In the context of play, endings can be either *open* (infinite) or *closed* (finite) [6, 56]. *Open-ended play* has no predefined goal [66] and gives no indication when play should end, allowing players to decide for themselves when to stop [53]. *Closed* games have (one or more) clearly designed goals or conditions that result in their ending, such as being ‘game over’ (losing) after too many mistakes or achieving the objective (winning) through a series of correct actions.

2.2.3 Play Endings & User Experience. Open-ended play can support creativity [4] and imagination and lead to diverse forms of play [66]. It can be implemented to foster motivation and engagement by giving players freedom and autonomy [55]. Self-determination theory [53, 54, 64] states that motivation is fostered by autonomy, relatedness, and competence. Because players can experience more autonomy in open ended play, this could lead to higher motivation. This could indicate that open ended play has the potential for better UX, relating to positive attitude towards replay. But is this the case for any type of open-ended play?

In contrast, research provides indications for the relation between challenging play and positive user experience. Goal-setting theory suggests that setting specific and challenging goals can enhance performance and motivation [38] and that clear, well-defined, and measurable goals improve performance much more than vague objectives [5]. This resonates with Lazzaro’s ‘*hard fun*’ [34]. They explain game design approaches of how games can create emotion without story. Hard fun explains that players can be motivated to play by having to overcome obstacles. And that emotion in gaming can be created by creating frustration and personal triumph, and by structuring experiences towards the pursuit of a goal.

Loss aversion is a concept originating in behavioral economics and explained by Kahneman as: “*The response to losses is stronger*

than the response to corresponding gains”. Research shows that players exhibit a strong bias towards avoiding losses [3]. In the context of a VR game, Ventura et al. [70] found that players were more engaged when losing a game against a virtual opponent than when winning.

In summary, goal-setting theory, Lazzaro’s concept of hard fun and loss aversion provides indications that closed endings might lead to a more positive user experience which could lead towards a positive replay intention.

2.3 Our study

We learned from previous research:

- Positive (remembered) user experiences are related to a positive attitude to repeat an activity
- Endings are important for a positive remembered user experience

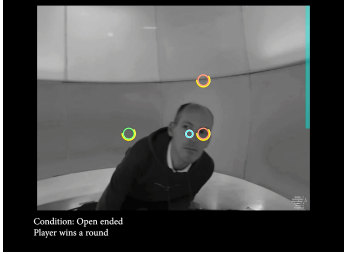
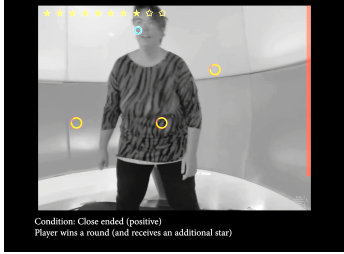
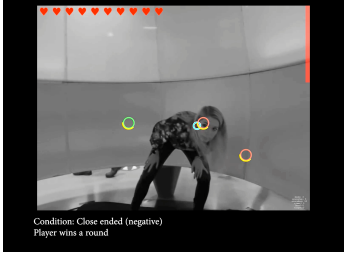
This leads to the expectation that positively experienced endings can lead to a positive attitude towards replay. There is however still a lot unknown about the relation between these aspects. In our study, we therefore explore the relation between endings, user experience and attitude towards replay of an interactive playful experience in the semi-situated context of a science center. Through our findings we aim to contribute to the field of HCI and UX design for interactive spaces, by providing insights into the relation between play endings, UX and replay attitude. This contributes to understanding how to design engaging play experiences that people want to use repeatedly.

3 Method

3.1 Ethics Approval

Before starting the study, ethics approval was obtained from the Ethics Review Committee of Leiden University. The study protocol was reviewed and approved under reference number 2022–017. All participants were informed about the nature of the study, and informed consent was obtained prior to their participation. All participants whose images are included in this paper and related presentations, agreed to their images being used for this purpose.

Table 1: Ending Conditions

Condition	Open	Closed positive (winning)	Closed negative (losing)
Ending	Players decide when to stop playing	Game ends after collecting all 10 stars (rounds won)	Game ends after losing all 10 hearts (rounds lost)
Screenshot			

3.2 Game

We created a single player game in P5.js [23] using computer vision as input technology (using the ml5 library [44]) with a Logitech BRIO HD webcam for input. For projection we used a short-throw projector (Optoma) to avoid obstructions (shadows).

The players saw themselves projected on a live-size screen with a round marker on the location of their nose. The goal for each round was to hit all three targets with their nose, before time ran out. The game has three different ending conditions: open, closed positive and closed negative (Table 1). All rounds were equal for all three conditions. The location of targets and playing time for each round is hard coded into the game. Every play session started with one practice round. The players were randomly assigned to one of the ending conditions. The ending goal, rounds played, and time played are variables that were registered for each player.

3.3 Location

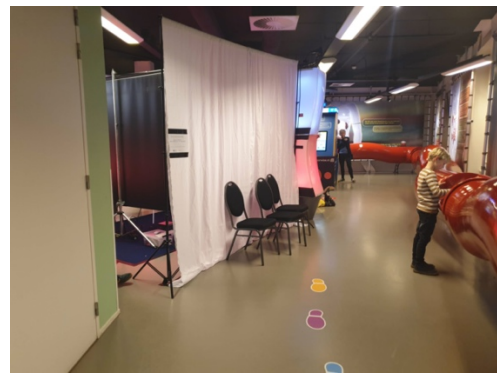
We conducted our study in a semi-situated context within *Corpus*, a science center in the Netherlands, that is centered around a ‘*Journey Through the Human Body*’. Conducting our study in a real-world context with actual visitors, closely resembles real-world conditions, ensuring that participants engage with the IPS in a similar context and mindset.

Visitors first went on a guided multimedia journey through the human body, followed by multiple floors of interactive sponsored exhibits. Visitors reached our temporary research exhibit (Figure 4) in the second exhibition space after finishing their journey. It was located on the spot of a former, now removed, exhibit, adjacent to other, permanent exhibits.

The playing area for our experiment was separated from the general exhibition area and the tables where the surveys were conducted. This way, non-players could not see the current game (they could still hear it) and would not distract the player. Players could not see other visitors during play. A researcher was present in the play area during the practice round. They stood out of sight of the player during play.

3.4 Procedure

Figure 5 gives an overview of the workflow of our experiment. Visitors to the museum, when passing by the experiment location

**Figure 4: Location of the experiment in the exhibit space**

(Figure 4), were asked if they were interested in participating in a study. A brief explanation was given that the research was about getting insight into the design of interactive play exhibits such as those in the museum they were currently visiting. In addition, it was explained that participation would require the visitor to complete a questionnaire, play a game and complete an additional questionnaire, and that participation was expected to take approximately 10 minutes. Players voluntarily participated in our study, without any form of compensation.

Participants were then guided to a table with a laptop to fill in a consent form and the pre-play questionnaire. Following, they were guided to the play area (Figure 1) and given brief instructions. They were explained: “*You will see yourself on screen, with a marker approximately on the location of your nose. The goal for each round is to hit the three targets before time runs out*”.

Each participant was randomly assigned an ending condition by the game: *open*, *closed positive (winning)*, or *closed negative (losing)*. Players were not made aware of the existence of other ending conditions. For the open condition players were told they could decide themselves when to stop playing. For the closed negative (losing) condition they were told that for each missed round, they would lose a heart, and the game would end after all ten hearts were gone. For the closed positive (winning) condition they were told that for each completed round, they would get a star, the game

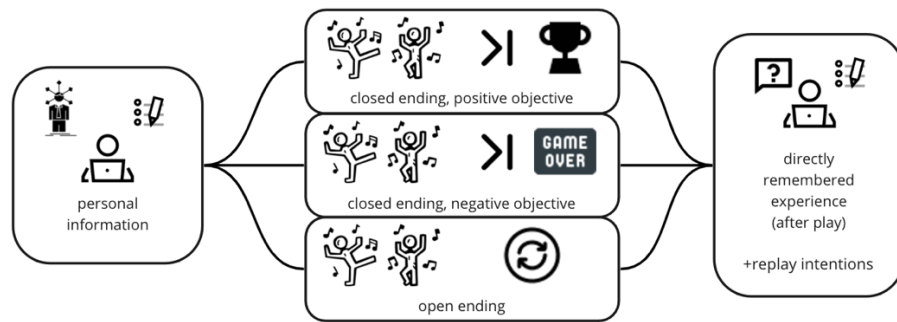


Figure 5: Experiment Workflow

Table 2: Extra questions in after play questionnaire

Concept	Question	Answers	
Self-reported Ending	Why did you stop playing?	- I lost - I won - I chose to stop playing because ... - Other reason (please specify) ...	closed negative closed positive open other
Attitude towards Replay	Can we approach you for another play session with this game?	- Yes - No	

would end by collecting all ten stars. After playing, the players filled in the post-play questionnaire.

3.5 Measures

Before playing, participants filled in a questionnaire with general questions about themselves (gender, age). After playing, participants filled in a second questionnaire which included the User Experience Questionnaire (UEQ) [33], and the (international, short-form) Positive and Negative Affect Schedule (I-PANAS-SF) [29, 71].

The UEQ is amongst the most recognized standardized questionnaires for UX evaluation [14]. The UEQ-dimensions cover a comprehensive impression of user experience. Both pragmatic (Efficiency, Perspicuity, Dependability) and hedonic user experience aspects (Originality, Stimulation) are measured [65], supplemented by a valence dimension: Attractiveness. The UEQ consists of 26 word-pairs that form 6 scales. Each word pair is scored on a 7-point scale and is scaled from -3 (most negative) to +3 (most positive) (Following instructions in the UEQ-Handbook).

PANAS is a well-established tool for assessing affective experiences, capturing both positive and negative affect. PANAS is commonly used in combination with the UEQ [15]. The PANAS-Questionnaire consists of 20 items that are scored on a scale of 1 to 5. Scores for positive or negative affect are accumulated and range from 10 – 50 for each dimension, with higher scores representing higher levels of positive or negative affect.

In addition to the standardized UEQ and short form of the PANAS questionnaires, there were two questions, one about why they stopped playing (self-reported ending) and one about whether they could be approached for another play session (replay attitude) (Table 2).

The game that was created for this experiment saved the number of rounds played, playing time and assigned ending, in a .csv file.

In this paper we make a distinction between *assigned ending*, meaning the ending that was assigned to the players, auto-selected by the game, and *self-reported ending*, indicating how a player reported why they stopped playing the game.

3.6 Analysis

We used Qualtrics for pre- and post-play questionnaires. Data was gathered and combined in Excel.

PANAS-positive and -negative dimensions were calculated from the PANAS items. UEQ-data was rescaled, and UEQ-dimensions were calculated using the provided UEQ-data-analysis excel sheet.

SPSS (v.29) was used for data-analysis. Descriptive statistics were calculated to provide insight into the general characteristics. When performing multiple tests, we applied a Holm-Bonferroni correction to reduce the likelihood of type 1 errors.

4 Results

4.1 Participants

The three assigned ending conditions were open ($n=28$), closed positive (winning) ($n=40$), and closed negative (losing) ($n=25$), resulting in a total sample size of 93 participants. Conditions were randomly assigned by the game (without counterbalancing).

Participants were between 18 and 73 years old ($M=44.2$, $SD=10.2$). Participants in the *open* ending condition ($n=28$; 13 male; 15 female) were between 18 and 50 years old ($M=42.1$, $SD=7.4$). Participants in the closed positive condition ($n=40$; 13 male; 22 female; 1 non-binary; 2 otherwise specified; 2 preferred not to say) were between 19 and 73 years old ($M=46.4$, $SD=12.0$). Participants

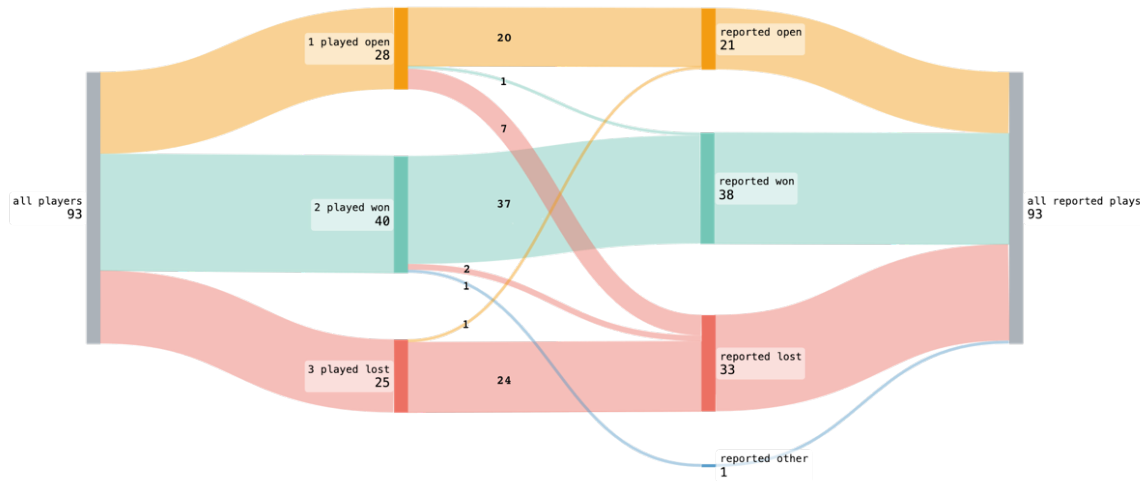


Figure 6: Sankey diagram visualization of distributions of assigned (left) vs. self-reported (right) play endings, illustrating how players in each assigned condition self-reported their ending condition.

in the closed negative condition ($n = 25$; 11 male; 13 female; 1 non-binary) were between 20 and 67 years old ($M = 43.0$, $SD = 9.6$) (Appendix A, Appendix B).

4.2 Effects of Experimental Play Conditions

Our first research question was: How do different ending goals affect user experience of IPS?

A Multivariate Analysis of Covariance (MANCOVA) was conducted to examine the impact of *assigned ending* conditions (open, closed positive, closed negative) on the dependent variables: User Experience Questionnaire (UEQ) dimensions, Positive and Negative Affect Schedule (PANAS), and Replay Attitude. The number of rounds played was considered as a covariate in the analysis to control for potential confounding effects.

The analysis resulted in a non-significant Wilks' Lambda ($\Lambda = .796$, $F(18, 160) = 1.072$, $p = .385$). This indicates that there were no statistically significant differences in the combined dependent variables (UEQ dimensions, PANAS, Replay Attitude) induced by the assigned ending conditions, after controlling for the number of rounds played.

4.3 Effects of Perceived (self-Reported) Play Conditions

4.3.1 Assigned vs. Self-Reported Endings. Participants were asked to self-report how they ended their play session in the post-play questionnaire (*self-reported ending*). The results show differences between participants' *assigned ending* and their *self-reported ending* (percentage agreement = 87.0%) (Figure 6).

Of the 28 participants who were assigned the *open ending* condition, 20 participants (71%) self-reported their ending condition similarly. Eight participants (29%) self-reported their open ending condition differently. Of which, one participant reported their

open ending as *closed positive* and seven participants reported their ending as *closed negative*.

Of the 40 participants who were assigned the *closed positive* (winning) condition, three (8%) participants reported their ending differently. Of which two reported their ending condition as *closed negative* (losing), and one reported their ending as *other*.

Of the 25 participants who were assigned the *closed negative* (losing) condition, one (4%) reported their ending as *open*.

A chi-square test of independence was performed to evaluate the relationship between assigned and self-reported endings. The relationship between these variables was significant, $\chi^2(6, N = 93) = 126.76$, $p < .001$. Participants in the *assigned open-ended* condition exhibited a significantly higher rate of differently self-reported endings, compared to the other assigned ending conditions.

4.3.2 Self-Reported Endings (open, closed positive, closed negative) & UEQ, PANAS, Replay. Because many people perceived their ending condition differently than their assigned ending condition, we conducted further analysis on their self-reported endings.

A Multivariate Analysis of Covariance (MANCOVA) was conducted to examine the impact of self-reported endings (open, closed positive, closed negative) on UEQ, PANAS, and Replay Attitude, while controlling for the covariate of rounds played. For this analysis, we excluded the participant who answered 'other' to the self-reported ending question.

The Wilks' Lambda multivariate test for reported endings (open, closed positive, closed negative) yielded a non-significant result, suggesting no significant overall effect on UX and affect ($\Lambda = .777$, $F(18, 160) = 1.194$, $p = .272$).

No significant differences were found for UEQ-Attractiveness ($F(2, 160) = 0.982$, $p = .379$), UEQ-Perspicuity ($F(2, 160) = 1.067$,

Table 3: MANCOVA self-reported endings (open, closed (grouped positive and negative))

Dependent Variable	F	Sig.
UEQ – Attractiveness	1.848	.177
UEQ – Perspicuity	1.052	.308
UEQ – Efficiency	1.043	.310
UEQ – Dependability	.329	.568
UEQ – Stimulation	6.332	.014
UEQ – Novelty	.001	.981
PANAS positive affect score	3.240	.075
PANAS negative affect score	.752	.388
Attitude towards replay	.859	.357

$p = .348$), UEQ-Efficiency ($F(2, 160) = 0.699$, $p = .500$), UEQ-Dependability ($F(2, 160) = 0.167$, $p = .846$), and UEQ-Novelty ($F(2, 160) = 0.169$, $p = .845$).

However, a significant effect was observed for UEQ-Stimulation ($F(2, 160) = 4.816$, $p = .010$), indicating differences in this dimension related to perceived ending conditions. Players who self-reported their ending as closed negative scored significantly higher on UEQ-Stimulation ($M=1.2273$, $SD=0.87581$), compared to open ($M=0.4286$, $SD=0.95898$) and closed positive ($M=0.9474$, $SD=0.79940$).

There were no significant effects for PANAS Positive Affect ($F(2, 160) = 2.330$, $p = .103$) and PANAS Negative Affect ($F(2, 160) = 0.641$, $p = .529$). Attitude towards replay did not show a significant effect across ending conditions either ($F(2, 160) = 1.566$, $p = .215$).

4.3.3 Self-reported Endings (open, closed) vs. UEQ, PANAS, Replay. Literature on play and gaming primarily distinguish either open or closed endings. Therefore, for this analysis we grouped all participants who self-reported their ending as *closed* (including both *closed positive* and *closed negative*), resulting in two remaining groups (*open* and *closed*). We excluded the participant who answered ‘other’ to the self-reported ending question.

Again, a multivariate analysis of Covariance (MANCOVA) was conducted to examine the effect of self-reported endings (open, closed) on UEQ, PANAS, and replay attitude with rounds played as covariate (Table 3).

Results show that the self-reported ending condition did not have a significant effect on the UEQ Attractiveness, Perspicuity, Efficiency, Dependability and Novelty dimensions.

However, for the UEQ Stimulation dimension, a statistically significant effect was found ($p = .014$). This indicates an influence of self-reported ending conditions on users’ perceived stimulation. The results indicate that players who self-reported their ending as closed scored significantly higher ($M= 1.0775$, $SD = .84155$) than players who self-reported their ending as open ($M = .4286$, $SD = .95898$). This resonates with the results in section 4.3.2.

Self-reported ending conditions did not significantly affect PANAS Negative Affect or the attitude towards replay. For PANAS Positive Affect, a non-significant but marginal effect was found ($p = .075$).

4.3.4 Correlation Analysis. A correlation analysis showed statistically significant relations between replay attitude and several

UX-dimensions (Table 4). Specifically, attitude towards replay exhibited a significant positive association with the UEQ dimensions Attractiveness ($r = -.237$, $p = .022$), Dependability ($r = -.282$, $p = .006$), Stimulation ($r = -.239$, $p = .021$), and PANAS positive affect ($r = -.268$, $p = .009$). No significant correlations were observed for UEQ Perspicuity, Efficiency, Novelty, and PANAS negative affect.

These results suggest that specific dimensions of user experience (*Attractiveness*, *Dependability*, *Stimulation*) and *PANAS positive affect* significantly contribute to users’ *attitude towards replay*. Participants who scored higher on these aspects were more likely to have a positive attitude towards replay.

5 Discussion

In the study presented in this paper we addressed the following questions:

- How do different endings affect user experience of IPS?
- What is the relation between user experience and attitude towards replay in IPS?
- How do different endings affect attitude towards replay of IPS?

We address these research questions in the next three sections. Following, we explain insights on self-reported endings that emerged as a side effect in our study. These do not answer one of the primary research questions directly but are of importance in our study because they provided rationale for additional analyses on self-reported endings and are relevant for future HCI research. Finally, we discuss what our results mean for HCI and UX design and discuss considerations regarding our research approach.

5.1 Play Endings & User Experience

The first research question was: ‘How do different ending goals affect user experience of IPS?’.

Our results show no significant differences in user experience between *assigned* ending conditions. However, (post hoc) analysis of *self-reported* endings shows a significant effect of self-reported endings on UEQ-Stimulation. Players who self-reported their ending as *closed-negative (losing)* scored significantly higher on *UEQ-Stimulation*.

These findings resonate with a study by Venture et al.[70], who found player engagement to increase when their virtual opponent was outperforming them, causing them to lose. Although player engagement and stimulation are not exactly the same, based on these results, further research into whether losing (in itself a rather negative thing) has a relation with positive UX, would be interesting. Loss aversion bias could provide another reason for closed (negative) endings to be experienced more stimulating than other endings. Loss aversion explains that negative feelings associated with prospective losses carry more weight than the positive feelings of winning [3].

When positive and negative closed self-reported endings were grouped as closed, players who self-reported their ending as closed also scored significantly higher on *UEQ-Stimulation* and scored marginally but non-significantly higher on *PANAS positive*, compared to players in the self-reported open condition.

Goal-setting theory [38] can provide an explanation for these results. A closed ending is specific, clear and well-defined and

Table 4: Correlation Analysis

		Play- ing time	Rounds played	UEQ – Attrac- tive- ness	UEQ – Per- spicu- ity	UEQ – Effi- ciency	UEQ – De- pend- ability	UEQ – Stimu- lation	UEQ – Nov- elty	PANAS posi- tive affect	PANAS nega- tive affect	Atti- tude to- wards replay
Playing time	Pearson Correlation	1	.968**	-.197	-.379**	-.309**	-.029	-.276**	-.174	-.160	.126	.007
Rounds played	Pearson Correlation	.968**	1	-.136	-.303**	-.267**	-.016	-.254*	-.098	-.140	.110	.017
UEQ – Attractiveness	Pearson Correlation	-.197	-.136	1	.616**	.795**	.606**	.715**	.638**	.449**	-.151	-.237*
UEQ – Perspicuity	Pearson Correlation	-.379**	-.303**	.616**	1	.637**	.381**	.574**	.498**	.398**	-.033	-.086
UEQ – Efficiency	Pearson Correlation	-.309**	-.267**	.795**	.637**	1	.611**	.656**	.575**	.479**	-.147	-.187
UEQ – Dependability	Pearson Correlation	-.029	-.016	.606**	.381**	.611**	1	.576**	.282**	.503**	.016	-.282**
UEQ – Stimulation	Pearson Correlation	-.276**	-.254*	.715**	.574**	.656**	.576**	1	.397**	.529**	-.079	-.239*
UEQ – Novelty	Pearson Correlation	-.174	-.098	.638**	.498**	.575**	.282**	.397**	1	.207*	-.254*	.013
PANAS positive affect score	Pearson Correlation	-.160	-.140	.449**	.398**	.479**	.503**	.529**	.207*	1	.290**	-.268**
PANAS negative affect score	Pearson Correlation	.126	.110	-.151	-.033	-.147	.016	-.079	-.254*	.290**	1	.003
Attitude towards replay	Pearson Correlation	.007	.017	-.237*	-.086	-.187	-.282**	-.239*	.013	-.268**	.003	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

potentially challenging. Goal-setting theory indicates that goals with these characteristics have positive effects on performance and motivation. This could explain why closed negative endings, that have a clear goal relate to a positive effect on UEQ-Stimulation within user experience in our study.

Another (related) explanation can be found in Lazzaro's '*hard fun*' [34] that explains that players can be motivated to play by overcoming obstacles. And that emotion is created through frustration and personal triumph, and by structuring experiences towards

the pursuit of a goal. In our study the closed conditions had a clear goal, whereas the open condition had no ending goal.

Further research would be needed to better understand the role of goal-setting theory, hard fun and loss aversion bias, and their relation with user experience and specific game design approaches (such as a negative closed ending), especially in the context of IPS. This will benefit the design of positive user experiences, supporting interfaces in achieving the goals for which they are intended.

5.2 UX & Attitude towards Replay

Our second research question was: ‘Does user experience relate to attitude towards replay in IPS?’.

Our findings indicate a significant relation between specific dimensions of user experience and affect, and attitude towards replay. Specifically, UEQ-Attractiveness, UEQ-Dependability, UEQ-Stimulation, and Positive Affect (PANAS positive) were positively associated with participants’ attitude towards replay. This provides a positive answer to our second research question: *User experience relates to attitude towards replay.*

Interestingly, while previous studies [12][24]) already emphasized the role of hedonic dimensions—such as perceived enjoyment—in shaping attitudes and intentions, our results broaden this understanding. We found that not only Hedonic (Stimulation) but also Pragmatic (Dependability) and Valence (Attractiveness) dimensions, correlate with Attitude towards replay.

With regard to affect, our results align partially with the mixed outcomes in prior work. Some studies using PANAS found no consistent relation between affect and intention (e.g., [31]), while others, particularly in digital or entertainment contexts, have identified positive emotions as influential (e.g., Bae et al. [2]). Our data supports the latter: higher Positive Affect scores were associated with more favorable attitudes towards replay. This resonates with findings from marketing and game studies [49], [2], where emotional responses to novelty or pleasure were found to influence behavioral intention.

However, our findings also differ from previous work. A contextually related study into AR vs. VR exergames by Hensley [22] found no significant differences in positive and negative affect between AR and VR. There were also no significant differences in intentions for future engagement in the exergame between conditions. They however do not mention analyzing correlation between PANAS scores and future engagement intentions.

Previous research is divided regarding the relationship between UX and attitude towards replay and intention. However, these are two slightly different concepts in relation to predicting behavior. Our research shows a clear relationship between UX and attitude. Although our survey was limited, this provides sufficient reason to investigate further in follow-up research how these relationships work and also very importantly, how to design for this.

5.3 Play Endings & Attitude towards Replay

Our third research question was: How do different endings affect attitude towards replay of IPS?

Our results regarding play endings and UX indicate a relation between (perceived) self-reported play endings and UEQ-Stimulation. Our results regarding UX and attitude towards replay indicate relations between UX aspects and attitude towards replay, among which UEQ-Stimulation. However, no direct relation between (assigned and perceived) play endings and attitude towards replay was found.

Further research is needed to investigate the possible relationship between game endings and attitude towards replay. We acknowledge that our approach was limited. There are many other ways to design open and closed endings in play that might be able to evoke stronger feeling between ending conditions.

5.4 Differently Reported Assigned Open Endings

In our study, a large part (29%) of the players who were assigned an open-ended condition reported their ending differently. This resonates with findings in a study by Nebel et al. [45]. In their study, participants were given either a learning goal, performance goal or no goal. Of the participants in the goal-free condition only a minority remembered having no goal and the majority instead reported they had a learning goal. In both our study and the study by Nebel et al., many participants in the goal-free (open-ended) condition misinterpreted their participation goal. They were however convinced that their assumed goal was correct to such extent that they reported it afterwards.

Looking at the differences in UEQ outcomes between the differently and similarly self-reported open endings, we can assume that the participants who reported their ending differently not only remembered it differently, but actually experienced it as such during play.

An explanation for the differences in assignment and self-report of goal-free objectives could be that people base their expectations of what a new situation will be on their previous experiences (‘prior beliefs’) [25]. In our case players could have had the preconceived expectation that games always have a closed ending. This resonates with the ‘Expectation bias’, that states that people’s expectations about the outcome of a situation affects how they perceive information they receive.

Another explanation could be the occurrence of ‘confirmation bias’ [21][10] – the inclination to selectively interpret information so that it aligns with someone’s preconceptions. This aligns with Suchman’s theory of situated action [61] that emphasizes that people attribute meaning through interaction rather than beforehand [67].

Lastly, the ‘Recency effect’ could also play a role here because the previous exhibits that players encountered in the science center before participating in our experiment were all closed ended with a competitive objective.

We expect that different interpretations of playing goals happens more often and in other situations but isn’t always noticed. In both our study and the study by Nebel et al. [45] ‘Goal-free different reporting’ was discovered because participants were asked to self-report afterwards. In studies where researchers rely solely on assigned goals, this may lead to data being miscategorized in the context of open-ended or goal-free conditions. We suggest requiring participants to self-report on their playing goals and endings in future studies that involve goal-free or open-ended characteristics.

Furthermore, we suggest further research into the occurrence of this phenomenon. To better understand goal remembering and interpretation we need better insight into why and when this happens and how it influences user experience.

5.5 Implications for HCI & UX Design

From our results we cannot conclude that any of the game endings directly influenced attitude towards replay. However, we see that perceived (self-reported) closed (negative) play endings correlate with higher UEQ-Stimulation. To design for replay in IPS, we suggest designing their goals in such a way that the user experiences

a feeling of stimulation, possibly through a closed ended approach (stimulating loss aversion[3, 70]).

In general, for the design of IPS, our results indicate that evoking positive reported user experiences after playing is suggested, as dimensions of UX relate to attitude towards replay. Our results show that players in the closed ending (losing) condition scored higher on stimulation. This supports designing play with a closed negative ending, where players lose. More research is needed to understand which (other) design aspects support positive UX.

However, there might be other design features that are more capable at evoking positive UX, leading to a positive replay intention. Further research is needed to better understand which design features positively influence stimulation in a game.

5.6 Approach & Future Work

5.6.1 Counterbalancing Conditions. In our study, ending conditions were randomly assigned by the game, without counterbalancing. This led to unbalanced numbers of participants for the different conditions. For future experiments we suggest counterbalancing to have equal numbers of participants for each condition. However, with our findings regarding ending conditions being perceived differently this could still result in (slightly) unbalanced participant numbers.

5.6.2 Measuring UX. In this study we focused on measuring hedonic and pragmatic UX, with the UEQ and PANAS. Future work could include other ways of measuring emotions that can be promising to gain better insights into UX during use such as quantitative analysis, or computer vision to analyze facial expressions of emotions [73] during play. Besides endings, this could also provide more insights into the role of *peaks* on UX and replay intention.

5.6.3 Longitudinal & Retrospective UX. In this paper we describe UX that is reported immediately after playing with a system that is novel to the participants. This represents a real-world context where a museum visitor encounters an interactive exhibit for the first time and then upon a second visit will decide whether or not to engage again based on those previous experiences.

For IPS, repeated use is often part of their objective, such as sports and rehabilitation interfaces and it is interesting to see what happens to UX when they are used repeatedly, and novelty wears off over time. Hensley et al. [22] mention novelty as a factor to relate to positive attitudes towards future engagement. This illustrates the importance of studying UX for situated interfaces longitudinally after prolonged use to avoid the potential influence of novelty. We suggest conducting further studies to understand how important the role of novelty actually is.

For better understanding of replay attitude, particularly how replay intentions evolve over time, we suggest measuring UX after prolonged use, and longitudinal or retrospective remembered UX. For future studies into the prolonged use of these systems, we suggest also looking into eudaimonic UX. This allows for understanding the effects of these systems after they have been used repeatedly over longer periods.

5.6.4 Measuring Attitude towards Replay. Our way of questioning attitude towards replay through a single question was limited. However, it still provided some interesting insights that provide

reason for further research. For future research we suggest looking into multiple dimensions for replay attitude or intention to gain better insight into the effect of UX and ending conditions on replay. Ideally, we suggest further studies that require players to make an actual decision to play again (or not), to go from behavioral intention to actual behavior.

5.6.5 Game Complexity. In this study, we have used a relatively simple and straightforward game environment. However, most gaming environments are much more complex and multi-layered. As a result, there are many more dimensions that can influence one another, particularly in real-world contexts. Despite focusing on a single aspect, our research provides valuable insights into the functioning of a specific dimension - ending, which contributes to a deeper understanding of its role. Our results indicate that it's worthwhile to take into account endings when designing IPS. These insights can also help inform the design of more complex interfaces, leading to improved user experiences in more sophisticated environments.

5.6.6 Semi-Situated Research. Lastly, we want to highlight the importance of studying Interactive Play Spaces in a setting that is as similar as possible to the setting in which these systems would be implemented in a real-world context. Because we conducted our experiment in the semi-situated context of a science center, we had access to an actual audience as a user population. This resulted in a realistic population. We argue that results from user studies conducted in a realistic or semi-realistic setting are highly relevant when attempting to understand how to design for interactive systems in situated contexts.

6 Conclusion

In the study presented in this paper we investigated how different types of play endings affect user experience, and what the relation is between user experience and attitude towards replay.

No effect of assigned ending condition on user experience was found. However, many players reported their ending differently. Players in the assigned open-ended condition were significantly more likely to report their ending differently. For future research, we therefore recommend asking participants to self-report on characteristics of their lived experience as this might differ from assigned conditions.

Analysis on perceived, self-reported endings indicated interesting effects. Players who self-reported their ending as closed negative scored significantly higher on UEQ-Stimulation. And when grouped, players who self-reported their ending as closed, also significantly scored higher on UEQ-Stimulation and marginally higher on PANAS-positive.

Furthermore, specific dimensions of user experience (UEQ: Attractiveness, Dependability, Stimulation) and PANAS positive, indicate a significant positive relation with a positive attitude towards replay.

Our study contributes to a better understanding of the working mechanisms behind design aspects of Interactive Play Spaces, specifically endings and the relation between user experience and replay intention. We illustrate the importance of asking participants to self-report on characteristics of their lived experience as

these might differ from given characteristics. Moreover, we show that (aspects of) user experience relate to attitude towards replay, which is important for developing play spaces that will be used repeatedly.

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APPENDICES

Appendix A: Age and gender per assigned ending condition

Assigned Ending	Age					Gender					Total
	N	Mean	Mini- mum	Maxi- mum	SD	female	male	non- binary	prefer not to say	prefer to self- describe	
Open	28	42.07	18	50	7.403	15	13	.	.	.	28
Closed Negative (losing)	25	43.00	20	67	9.587	13	11	1	.	.	25
Closed Positive (winning)	40	46.40	19	73	11.965	22	13	1	2	2	40
Total	93	44.18	18	73	10.229	50	37	2	2	2	93

Appendix B: Age and gender for each subgroup of assigned and self-reported ending conditions

Assigned & Reported Ending		Age					Gender					Total
		N	Mean	Mini- mum	Maxi- mum	SD	female	male	non- binary	prefer not to say	prefer to self- describe	
Open	Lost	7	41.29	27	49	7.544	5	2	.	.	.	7
Open	Open	20	42.50	18	50	7.681	9	11	.	.	.	20
Open	Won	1	39.00	.	.	.	1	.	.	.	.	1
Closed	Lost	2	65.00	64	66	1.414	2	.	.	.	.	2
Positive												
Closed	Other	1	41.00	.	.	.	.	1	.	.	.	1
Positive												
Closed	Won	37	45.54	19	73	11.587	20	12	1	2	2	37
Positive												
Closed	Lost	24	43.17	20	67	9.756	13	10	1	.	.	24
Negative												
Closed	Open	1	39.00	.	.	.	.	1	.	.	.	1
Negative												
Total		93	44.18	18	73	10.229	50	37	2	2	2	93

Appendix C: Paired assigned-reported ending conditions & playing time, rounds played – distributions

Assigned & Reported Ending		Playing Time					Rounds Played				
Assigned	Reported	N	Mean	Minimum	Maximum	SD	N	Mean	Minimum	Maximum	SD
Open	Lost	7	0:01:20.86	0:00:22.00	0:03:10.99	0:01:01.05	7	11.29	2	31	9.844
Open	Open	20	0:03:00.45	0:01:05.00	0:08:45.99	0:01:45.95	20	24.40	8	77	15.312
Open	Won	1	0:02:57.99	.	.	.	1	20.00	.	.	.
Closed	Lost	2	0:04:03.00	0:02:34.00	0:05:32.00	0:02:05.87	2	31	20	42	15.556
Positive											
Closed	Other	1	0:01:03.99	.	.	.	1	10	.	.	.
Positive											
Closed	Won	37	0:01:58.00	0:00:56.99	0:06:04.00	0:01:12.59	37	16.05	9	45	9.043
Positive											
Closed	Lost	24	0:02:37.62	0:02:02.99	0:04:02.00	0:00:33.12	24	22.71	15	40	7.244
Negative											
Closed	Open	1	0:03:06.99	.	.	.	1	29.00	.	.	.
Negative											
Total		93	0:02:22.35	0:00:22:00	0:08:45.99	0:01:19.34	93	19.65	2	77	11.186