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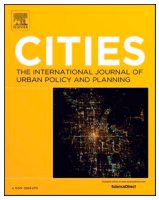

# Experiences of urban places mediated through pervasive games: An empirical study of place-based psychological responses

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ABSTRACT

This study investigates how pervasive games can engender and shape relationships with urban spaces, using as a case study the Walklets game experience in the neighborhoods of Is Mirrionis and San Michele in Cagliari (Italy). Walklets is a mobile based, narrative-driven pervasive game designed to encourage exploration and engagement with real-world environments. Through a mixed-methods approach combining pre-, post-, and follow-up surveys and thematic qualitative analysis, we assess the effects on several psychological variables: restoration, engagement, serendipity, emotions, and creativity. Findings show that Walklets had a significant positive impact on participants' perception and interpretation of the urban environment, enhancing emotional engagement, spatial awareness, and cognitive appreciation of places. Although some effects diminished over time, the qualitative data reveal long lasting mnestic traces and shifts in participants' relationship with the neighborhood. The study highlights the importance of narrative immersion, serendipitous discovery, and historical context in shaping meaningful experiences of urban places. We argue that pervasive games like Walklets can serve as tools for reimagining, learning about, and emotionally connecting with urban environments, offering new modes of experiencing the city.

## 1. Introduction

Recent empirical studies highlight how both traditional forms of play and technology-mediated games shape people's relationships with urban environments and support public health outcomes. Traditional interactions with public space, such as games and walking in urban parks, were shown to build emotional bonds and foster place attachment across cultures (Bazrafshan, Tabrizi, Bauer, & Kienast, 2021), while also correlating playfulness with higher levels of physical activity and health behaviors (Proyer, Gander, Bertenshaw, & Brauer, 2018). Playfulness has further been linked to design interventions that promote well-being and active ageing, demonstrating the public-health value of playful sensory experiences (Tsekleves & Darby, 2020). At the same time, the rise of location-based and augmented-reality games has transformed urban engagement by incentivizing movement, exploration, and serendipitous encounters. Case studies of *Ingress* and *Pokémon*-inspired AR games reveal how locative play re-enchants everyday spaces, mobilize positive emotions, and change patterns of social interaction in cities (Fragoso & Reis, 2016; Hjorth, & de Souza e Silva, 2023; Weber, 2017). Empirical trials confirm that AR-based cultural-heritage games can deepen emotional engagement with place and improve visitor experiences (Guo & Pan, 2023), while other interventions using gamified walking apps and public displays successfully increase physical activity in urban populations (Altmeyer, Lessel, Sander, & Krüger, 2018). Collectively, this body of work demonstrates that both traditional and digital forms of play can foster restoration, serendipity, and emotional connection to place, thereby underscoring the potential of playfulness as a mechanism for promoting urban health and community vitality.

### 1.1. Pervasive digital games

A core question concerning these research issues is what happens to the relationship between the player and the game environment in so-called *pervasive digital games*, where the game environment is not a virtual space experienced through a screen or a VR headset, but actual real-world places the player has to visit, explore and manipulate.

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Specifically, are such games capable of mobilizing meaningful psychological responses, and of what kind, with respect to the real-world places used as the game environment?

Pervasive digital games emerged with the development of mobile technologies. Indeed, these technologies have transformed the digital gaming landscape not only by allowing digital games to be played almost anywhere, but, also in the forms and expressions relevant to the present paper, by enabling the blending of boundaries between the game world and the real world (Hinske, Lampe, Magerkurth, & Röcker, 2007; Oleksy & Wnuk, 2017). Pervasive games extend the spatial, temporal, and social boundaries of traditional games that are confined to specific platforms (like a computer or a console), by incorporating aspects of the player's environment into the game environment.

While game studies would often focus on the game itself – on its design, mechanics, narrative, affordances, on how the virtual and the real are or aren't purposefully blended in the game, or perhaps on its symbolic, social, and cultural impact – in this work we turn our gaze onto the physical space which is part of the game environment. In short, in a pervasive game, what happens to space? Not that space gets physically transformed into pervasive games, or perhaps just sometimes and just slightly. Yet space may and indeed does undergo symbolic and normative transformation, it can evolve and acquire new meanings and values for players. Such gaming experiences can enrich one's sense of place and promote the re-appropriation of one's environment for exploration and storytelling (Apperley & Moore, 2019). Pervasive games in urban environments offer "opportunities for discovery" and can become an entry point for interactive narratives. This kind of games can also create unique "links" between virtual and physical layers, supporting a sense of co-presence through features that allow players to leave "digital traces" on the virtual correlate of the real-world environment (Leorke, 2019). In some cases, the ability to shape and re-appropriate spaces collaboratively also underscores the social and cultural impact of such games (Duarte & Álvarez, 2021; Liao & Humphreys, 2015).

More in general, and even beyond the domain of digital games, physical and virtual environments are increasingly perceived on equal footing, shaped by our activities, behaviors, and social connections (Ash & Gallacher, 2011; Harrison & Dourish, 1996) and, indeed, when a digital platform is habitually visited by the same people, creating social bonds and conveying culture, it becomes a nexus of habit and social activity (Dourish, 2006). Hence, pervasive digital games may offer opportunities for place-making, allowing people to re-encounter everyday spaces, to see them in a new and unexpected light, or to understand their history and origins more profoundly (Dourish, 2006). Additionally, this kind of technology may provide narratives of space, suggesting different ways of moving through the city (Spring, 2006), thus influencing how people experience cities, engage with urban practices, and negotiate cultural and historical representations (Knudsen & Waade, 2010; Towner, 1996; Urry, 2002).

### 1.2. Place experience and the role of pervasive games

What sparks our affection and attachment for certain places is a captivating question –one with many plausible answers (Cresswell, 2014; Lewicka, 2011; Oldenburg, 1999; Scannell & Gifford, 2017), and perhaps no single all-encompassing one. One path through which such bonds might develop – whether with real places or imaginary ones – is through digital games (Blečić et al., 2021; Dewailly, 1999; Plunkett, 2011; Tavinor, 2011). As a complex multi-sensory medium – following Janet Horowitz Murray (1997) in her prodigious masterpiece *Hamlet on the Holodeck* – digital games have a unique capability to sustain immersion, agency, and transformation of the game environment. Through these qualities, digital games can endow their game environments with symbolic and cultural meaning, engendering in players' emotional and affective relationships with the places depicted.

In his *The Objects of Affection*, Berger (2010) assembles a playful yet insightful catalogue of things he calls "the objects of our affection"—items enmeshed in our daily lives, shaped by the ideas we hold about how they should look, what they should do, and what roles they ought to play. Among these— thrown in the mix together with coffee, bikinis, teddy bears, and vacuum cleaners—Berger puts the videogame *Myst* (Berger, 2010, p. 153), created by the Miller brothers (Cyan, 1987). The choice is telling because he lingers on *Myst* and its power to cultivate emotional attachment – not so much to the game as a mere object, but for what it does to the player: a gateway into an experience of immersion and unfolding story through visiting new places, for which the player develops strong attachment and a long-lasting affection. In other words, rather than being an object of affection, the videogame *Myst*, as likely any persuasive virtual world, *can* create affection for places.

In this regard, pervasive games may transform urban unpredictability into a restorative playing field, where players can escape from daily stress (Hanson & Jones, 2015; Janeczko et al., 2020).

Equally central are emotions, which shape how individuals interpret and value urban spaces, and are deeply implicated in processes of place attachment, identity, and belonging (Boyle, Connolly, Hainey, & Boyle, 2012; Scannell & Gifford, 2017). Playful and narrative-driven experiences can intensify emotional engagement by encouraging immersion, empathy, and affective connection with local histories and communities (Apperley & Moore, 2019; Duarte & Álvarez, 2021).

Emotions play a crucial role in motivating engagement, and pervasive games should elicit a range of emotional responses through rich interactions with both the environment and the other players (Boyle et al., 2012). This emotional engagement can lead to a state of flow, where players are fully absorbed in the game, enhancing their connection to both the experience and the specific environment where the game occurs (Csikszentmihalyi, 1991). Concerning engagement, it was defined as the willingness to direct emotions and thoughts toward an activity, which is heightened as players immerse themselves in the game's narrative and goals (Gustafsson, Katzeff, & Bang, 2010; Lehner, Baldauf, Eranti, Reitberger, & Fröhlich, 2014). Finally, regarding creativity, it is encouraged as players shape their game experience, viewing the city not just for its "utility" but as a (con)text to be deciphered, leading to its exploration with "new eyes", reimagining the known, and discovering the unknown (Shubina & Kulakli, 2019).

With the advent of mobile technologies, pervasive games have become an interesting medium through which restorativeness, serendipity, and emotional patterns may converge in real urban environments. Unlike traditional games, which are typically confined to bounded spaces, pervasive games integrate digital narratives with everyday landscapes, transforming streets, landmarks, and neighborhoods into stages for exploration and play (Montola, Stenros, & Waern, 2009; Nijholt, 2017). Empirical research on location-based games - e.g. Pokémon Go - demonstrates their capacity to reshape mobility, promote physical activity, and reconfigure emotional relationships with neighborhoods (Althoff, White, & Horvitz, 2016; Kaczmarek, Misiak, Behnke, Dziekan, & Guzik, 2017).

In parallel, traditional forms of collective play, such as walking groups, have also been shown to yield public-health benefits, improving fitness and psychological well-being while strengthening social ties (Hanson & Jones, 2015). These findings underscore the broader potential of playfulness for health promotion, as highlighted by reviews connecting playful activity with stress reduction and well-being (McGonigal, 2011; Tonkin & Whitaker, 2019).

Despite this growing body of work, little is known about how narrative-driven pervasive games specifically shape urban experiences in disadvantaged neighborhoods, where stigma, ambivalence, and marginalization can complicate affective relationships with place. Do such games foster restorative experiences in stigmatized environments? Can they spark serendipitous discovery and emotional connection where neglect or decay dominate everyday perceptions?

### 1.3. The present study

To address these questions, the present study investigates the effects of playing a pervasive game, named "Walklets", that we specifically developed for the neighborhood of Is Mirrionis-San Michele in the city of Cagliari (Region of Sardinia, Italy). Walklets is a game platform based on interactive geo-telling, allowing narrative and adventure quests to be deployed by making players move, explore, and "*do things*" within places using a mobile web app. Using a mixed-methods approach (pre/post/follow-up surveys and thematic analysis), we explored whether and how the game influenced participants' perceptions of restorativeness, serendipity, and emotions, alongside engagement and creativity. In doing so, we aim to contribute to ongoing debates about playful urbanism, public health, and experiential strategies for urban regeneration.

Recent empirical work supports the idea that play - both traditional group walking and mobile, location-based games - can shape health and place relationships. Walking groups have been linked with a wide range of physiological and psychological benefits and strong adherence due to social affordances (Hanson & Jones, 2015). Large-scale analyses of location-based games (most prominently Pokémon Go) document increases in incidental physical activity and exploration linked to gameplay and social features (Althoff et al., 2016). These empirical results intersect with psychological models: Attention Restoration Theory explains how low-demand, engaging environments support cognitive recovery (Kaplan, 1995), while operationalizations of serendipity enable measuring chance discovery and its role in curiosity and creativity in digital and hybrid environments (McCay-Peet, Toms, & Kelloway, 2015). Taken together, this body of work suggests pervasive games can function as multimodal interventions that activate restoration, serendipitous discovery, and emotional meaning-making, mechanisms that are central to the present study.

### 1.4. Objective and hypotheses

In the present study, a pervasive game Walklets is hypothesized to "transform" everyday spaces endowing them with additional meanings and values, and fostering a positive relationship with the environment, deepening players' sense of place.

For the purpose of the study, we have conducted a series of group gaming sessions with a sample players. Before the actual gaming session, in what we call the Pre-experience phase, the participants were asked to fill in a questionnaire with a battery of self-report measures. Then after the gaming session, in the Post-experience phase, the participants were invited to fill in the same questionnaires, with some additional questions. Finally, in the Follow-up phase three months after the gaming session, we repeated the measurements.

With respect to these three phases (Pre-experience, Post-experience, and Follow-up), we formulated the following hypotheses:

- H1. Scores in the Post-experience phase in Fascination (H1a), Being Away (H1b), Coherence (H1c), Scope (H1d), Positive Emotions (H1e), Engagement (H1f), Serendipity (H1g), and Creative Freedom (H1h) are higher than scores in the Pre-experience phase; scores of Negative Emotions are lower (H1i).
- H2: Scores in the Follow-up phase in Fascination (H2a), Being Away (H2b), Coherence (H2c), Scope (H2d), Positive Emotions (H2e), Engagement (H2f), Serendipity (H2g), and Creative Freedom (H2h) are higher than scores in the Pre-experience phase and equal to the Post-experience; scores of Negative Emotions are lower than in the Pre-experience phase and equal to the Post-experience (H2i).
- H3: Satisfaction with the Walklets experience, Story-Telling, and Social Connections during the game are positively associated with Fascination (H3a), Being Away (H3b), Coherence (H3c), Scope (H3d), Positive Emotions (H3e), Engagement (H3f), Serendipity (H3g), and Creative Freedom (H3h) and negatively with Negative Emotions (H3i) in the Post-experience phase.

## 2. Method

### 2.1. Context

The neighborhood of Is Mirrionis-San Michele in the city of Cagliari (Region of Sardinia, Italy) was selected as a case study area due to its urban and social characteristics. This neighborhood covers an area of approximately 50 ha and contains over 30 % of the public housing built between 1960 and 1990 in the city (Saiu, 2018), making it the largest social housing area in Cagliari.

The study area is further marked by its rich social history (Santucciu, 2020). Indeed, until the early 1950s, the area was mainly agricultural fields. Following the damage caused to inhabited areas during the Second World War, there was a need for housing, particularly for the population streaming from the countryside into the big cities in search of employment. Due to ensuing economic hardship, some families are forced to settle in the only buildings on the edge of the city, the "Casermette" of the Is Mirrionis neighborhood, which were previously used only as wards of the nearby hospital. This step marks the genesis of the first urban residential core in the expanding district. The Italian state began constructing Public Residential Buildings throughout the country with the Fanfani plan, using funds managed by the National Institute of Insurance (INA) and INA-Casa Management. The aim was to revive the country's construction activity, provide housing for low-income families, and create employment opportunities for a considerable number of unemployed (Saiu, 2018). The first cluster of buildings was completed in three years, although the entire plan was developed for 14 years, with seven years dedicated to design and another seven to construction. Thus, comparing the 1953 and 1968 maps, the Is Mirrionis and San Michele neighborhood passed from being almost completely undeveloped to becoming urbanised and almost fully saturated. Currently, this area has the highest concentration of inhabitants, representing 12 % of the entire population of Cagliari, with a total of 18,229 residents as of 2022 (Municipality of Cagliari, 2022).

The study area is delimited by the natural morphology of the hill of San Michele, the urban park of Monte Claro, and the archaeological site of Tuvixeddu-Tuvumannu, which are located to the north, east, and south of the districts, respectively (see the Fig. 1). Despite the presence of three environmental attractions, various services, and several public buildings of importance for the entire city of Cagliari, this urban area has the widespread reputation of being "peripheral" both spatially and socio-economically. However, its geographical centrality and well-connected system to the city center and other areas make it attractive not only to residents of other city neighborhoods. Indeed, even the Municipality of Cagliari is very interested in the urban regeneration of these districts, as evidenced by the various projects that have been proposed and currently undergoing (Blečić, Muroni, & Saiu, 2023, 2024). The growing interest in this area is causing a shift in its perception as a "periphery". That is accompanied by the increasing real-estate values, signs of creeping gentrification, and the loss of historical references and associated memories.

### 2.2. Procedure

In this context, the Walklets game applied to the case of Is Mirrionis and San Michele neighborhood aimed to develop a positive relationship with the territory by offering both a break-up from ordinary routine and the possibility to have a playful and informative experience in an area that is building a new identity.

The backbone of the whole experience of Walklets is provided by the narrative-driven nature of its goals: the primary justification for strolling through the neighborhood is provided in the form of a mystery treasure hunt, whose objective revolves around finding the diary pages of

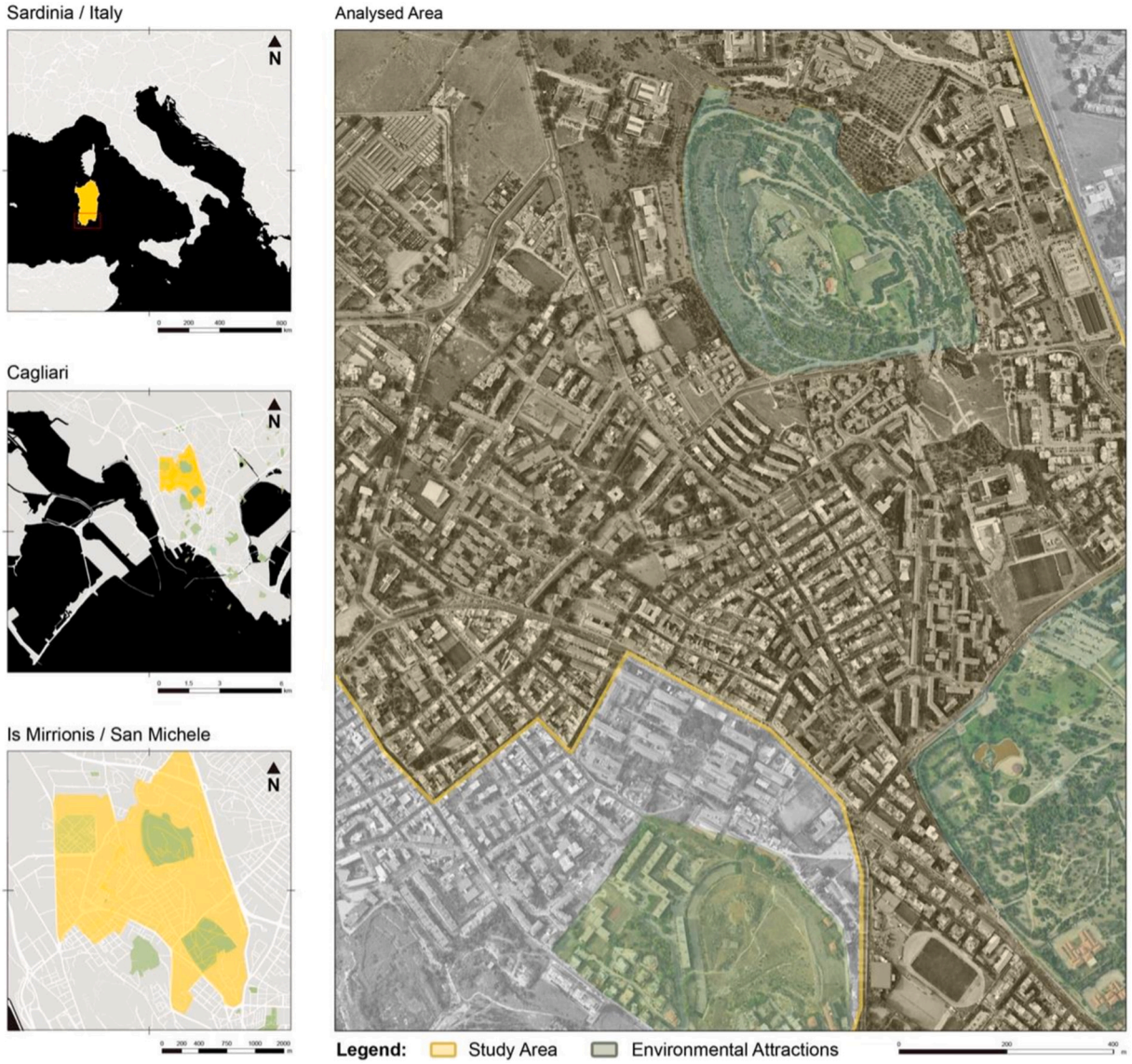


**Fig. 1.** Geographic location of the study area. [or] Case study: the neighborhood of Is Mirrionis and San Michele in the city of Cagliari (Italy).

Vittoria, an elderly woman who was a former psychiatric patient living in a former psychiatric hospital in the investigated area, to help her recover her memories lost after the dismissal. To achieve this aim, players listen to Vittoria's voice messages, visual clues, and diaries: the uncovering of some pages hidden in the cityscape landmarks reveals her story, alongside the history of the neighborhood itself. This narrative, while not referencing any real person, tells a story of unpleasant commonality: a girl, Vittoria, whose father disapproved of her involvement with the workers' movement in the neighborhood, and her journey of self-discovery and intimacy with another female classmate, leading to her unjust imprisonment in the psychiatric hospital Villa Clara in the Monte Claro Park (i.e., the starting point of the game) and following dehumanizing treatment of her "condition". The treasure hunt hence starts with Vittoria asking for help because she was finally dismissed from Villa Clara but at the same time lost her memories.

Participants were recruited using a non-probabilistic convenience sampling strategy via university mailing lists, word of mouth, and social media groups. This approach was selected due to the ecological and exploratory nature of the field intervention, which required flexibility and ensured that sessions could be conducted without interruption in the urban environment. Inclusion criteria were being at least 18 years old, owning a smartphone with internet access, and being physically capable of completing the 90-min walking route. While this strategy enabled rapid recruitment, it resulted in a sample being skewed toward students and non-residents and we explicitly acknowledge this as a limitation in terms of generalizability. Nonetheless, we consider the sample suitable for an exploratory field experiment of this type, and the diversity in age, educational backgrounds, and prior experience with pervasive games allowed us to capture a wide range of responses relevant to the study aims. Notwithstanding that, we hold that the findings are still a meaningful contribution to the debate, setting direction for further investigation and corroboration.

For the present study, we organized 18 gaming sessions, each with 6 participants (3 men and 3 women). Each group was accompanied by two members of the research team, whose role was to initiate the gaming sessions, offer minimal guidance and assist with installing the web app if needed, and administer the questionnaires before (Pre-experience) and after (Post-experience) the game – all while minimizing interventions and avoiding interference with participants during their actual play sessions within the neighborhood.

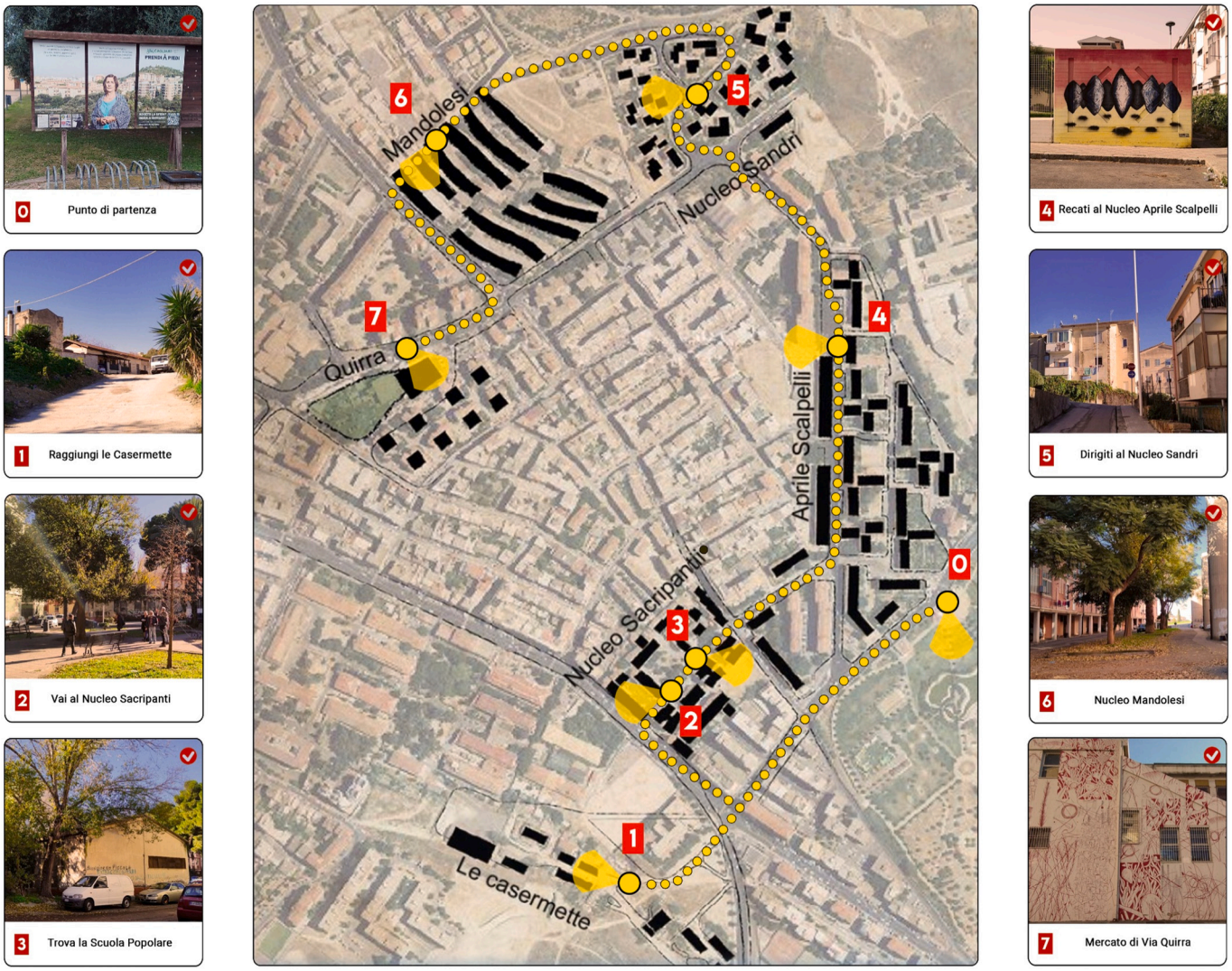


**Fig. 2.** Spatial sequence and eight-stage itinerary of the pervasive game across the study area

Every group met at the same point located in Monte Claro Park (see Fig. 2 for stages of the game) and was presented with the activity. Participants were asked to fill in a battery of self-report measures before starting the game and, on this occasion, they provided their informed consent. After that, the group started the game session using the web app Walklets. The game session with walks within the neighborhood had a duration of approximately 90 min. At the end of the Walklets experience, the participants were invited to fill in the same questionnaires administered before starting the pervasive game. Post-game dialogues were conducted to clarify eventual doubts and researcher team members took notes of such interactions. After three months a follow-up measurement was set.

The research was approved by the University of Cagliari for adherence to the Ethical guidelines for the processing of data for statistical or scientific research (Prot. n. 0224471). All data was anonymized and stored in accordance with GDPR requirements.

### 2.3. Sample

108[1] participants took part in the study divided into groups of 6 people. Their ages ranged from 18 to 66 years old ($M = 29.63$; $SD = 12.38$), half females and half males. Regarding education level, the majority of the sample held a High School diploma (60.2 %), 18.5 % held a Bachelor's degree, 12 % a Master's degree, 3.7 % a Ph.D. and 5.6 % a Junior High School diploma. About one-third of the sample (34.3 %) lived in Cagliari, but only a small proportion were residents of Is Mirrionis-San Michele neighborhood (approximately 4.63 % of the total). More than half of the sample (55.6 %) had no previous experience with pervasive games or other similar games. In the follow-up, 84 participants (i.e., 77.78 % of the initial sample) filled out questionnaires. An a priori power analysis for a repeated-measures ANOVA with three time points, assuming an effect size of $f = 0.12$, $\alpha = 0.05$, and desired power $(1–\beta) = 0.80$, indicated that a minimum sample size of $N \approx 110$ participants was required. Our actual sample of 108 participants is therefore very close to this requirement, indicating adequate power to detect the expected effect size.

### 2.4. Measures

A battery of self-reports was administered online, via Google Forms, in the Pre-game, Post-game, and Follow-up phases. In the battery, we included constructs investigating the physical, digital, and social environment of participants. The following measures were included:

[1] One participant was excluded due to extreme z-scores (>3 SD) across multiple variables, indicating data inconsistency, and also for several missing values.

- *Perceived Restorativeness Scale* (Hartig, Mang, & Evans, 1991; Italian version: Pasini, Berto, Brondino, Hall, & Ortner, 2014): it is composed of 11[2] items assessing the restorative components of the environment, and includes four different dimensions: Being Away, 3 items, (e.g.: "Experiences like this are a refuge from worries", α[3] = 0.75, 0.83, 0.74); Coherence, 3 items (e.g.: "I expect that there will be a sense of consistent progression in traversing the story about this place", α = 0.69, 0.77, 0.80); Fascination, 3 items (e.g.: "This place is fascinating", α = 0.79, 0.75, 0.71); Scope, 1 item (i.e., "In this place, there are few barriers or obstacles that have limited my ability to move around").
- *Geneva Emotion Wheel* (adapted from Scherer, Shuman, Fontaine, & Soriano, 2013): it measures different emotions and is composed of two dimensions verified through Exploratory Factor Analysis[4]: Positive Emotions, 10 items (e.g., "Right now I feel: Fun"; α = 0.91, 0.93, 0.91); Negative Emotions, 10 items (e.g., "Right now I feel: Disappointment"; α = 0.95, 0.91, 0.88).
- *Visitor Engagement Wheel* (adapted from Wilkinson, 2018): it is composed of 20 items, originally assessing the engagement of visitors in museums. For the present study, we adapted the items to an outdoor experience and focused on Positive Engagement, 12 items (e.g.: "I feel: Involved", α = 0.97, 0.97, 0.96).
- *Serendipitous Digital Environment Scale* (SDES, adapted from McCay-Peet et al., 2015): it measures the degree to which a digital environment allows for serendipitous discoveries. It is composed of 7 items (e.g., "I was able to see the ordinary world in new ways", α = 0.93, 0.91, 0.87).
- *Creative Freedom subscale*, included in the *Game User Experience Satisfaction Scale* (GUESS, adapted from Phan, Keebler, & Chaparro, 2016): it measures user satisfaction with digital games and is composed of 4 items (e.g., "I feel that the game has allowed me to be imaginative", α = 0.86, 0.87, 0.91).

The following measures were administered *only* in the Post-experience phase:

- *Story-telling subscale*: it is included in the Game User Experience Satisfaction Scale (GUESS; adapted from Phan et al., 2016), composed of 4 items (e.g., "I think the characters in the game are well developed", α = 0.78).
- *Satisfaction toward the Social Affordance capability of the Game subscale*: it is included in the Game User Experience Satisfaction Scale (GUESS; adapted from Phan et al., 2016), composed of 4 items (e.g., "I find that the game supports social interaction between players", α = 0.92).
- *Game of Inquiry Scale* (GCoIS; adapted from Soyturk, Gandolfi, & Ferdig, 2022): it measures user experiences with social games. For the present study, we administered only the subscale Social Connection, which is composed of 5 items (e.g., "I felt comfortable interacting with other game participants", α = 0.90).

The following open questions were administered at the beginning of the questionnaire in the Follow-up phase: "Which stage of the game surprised you the most? And why?"; "What is the strongest memory you have of the experience? And how do you feel when thinking back about it?"; "In general, what unexpected discovery struck you the most?"

Furthermore, questions regarding involvement in the game and the connection with the investigated neighborhood were included in the questionnaire of the Follow-up phase. Firstly, participants were asked if they would like to take part in an activity similar to that carried out in Is Mirrionis neighborhood ("Would you like to take part in a new activity like the one carried out in the neighborhood of Is Mirrionis?"), with "yes" or "no" responses. Subsequently, it was investigated whether participants visited again the game locations independently ("Have you visited again the game locations independently?"), with the same response options. Then, questions were asked about the participants' connection with the neighborhood: whether they ever lived there ("Have you ever lived in the Is Mirrionis neighborhood?"), whether they have important emotional ties (such as family) in the neighborhood ("Do you have any emotional ties, important to you, in the Is Mirrionis neighborhood? e.g., a family member"), and whether they had such ties in the past ("Have you ever had any emotional ties, important to you, in the Is Mirrionis neighborhood? e.g., a family member"). The responses to these questions were also "yes" or "no".

Finally, participants' opinions regarding several characteristics of the neighborhood were surveyed, with attention to the perceived difference before and after the gaming experience. The characteristics examined included the loss of open spaces, air pollution due to transportation, the health of flora and fauna, the health of the community in the neighborhood, and media attention in the local media. In this case, the response scale was a 5-point Likert scale (1 = Not concerned at all; 5 = Fully concerned).

### 2.5. Data analysis

To verify research hypotheses, a series of ANOVAs were performed with the three measurement times as between-subject factors and each measured variable as DV, to detect possible changes occurring between i) Pre-game and Post-game, ii) Pre-game and Follow-up and iii) Post-game and Follow-up phases. In addition, correlation analyses (Pearson's r) were run between Post-game users' satisfaction experience and other measured variables.

Concerning the qualitative analysis, data were collected in the Follow-up phase through open-ended questions designed to elicit reflective, descriptive, and affective accounts of the *Walklets* experience. The responses were analyzed following the six-phase Thematic Analysis procedure outlined by Clarke and Braun (2017) by two research teammembers (GLP e AM), who independently performed the initial open coding, breaking each response into meaningful segments and assigning descriptive codes that captured tone, narrative content, emotional valence, and symbolic references. Following this method, after transferring the answers into a spreadsheet, they were broken down into *codes* and units of meaning, which allowed more abstract and complex phrases to become *data*. A shared codebook was iteratively developed during this phase, containing coding rules, code definitions, and examples, allowing the researchers to refine the analytical boundaries of each code and ensure consistency. Discrepancies in coding were resolved through discussion until full agreement was reached. From the codes, the research team created *concepts* or groupings of semantically similar codes. Starting from the concepts, *categories* emerged, which effectively are the broad building blocks of the emerging *theory* that naturally flow from single codes. The frequency of the codes is also reported to better contextualize the source of the data itself in the broader context of the experience. Codes were grouped into higher-order concepts and subsequently into broader thematic categories. This process followed a constant-comparison logic aimed at theoretical saturation rather than quantification, although frequency counts were retained to contextualize the relative prominence of certain codes within the dataset. Reliability was enhanced through investigator triangulation, as both coders reviewed and revised the emerging concepts collectively, scrutinizing potential biases linked to age, disciplinary background, and cultural interpretation. The analytical work was carried out as follows: the two paper co-authors that conducted the analysis (AM, GLP) took the divided phrases of the qualitative data individually, and assigned codes to them

[2] In this study the following item "That place is large enough to allow exploration in many directions" was not administered since the neighborhoods investigated are a vast area per definition.

[3] The three Alpha values reported for each multi-item measure refer respectively to Pre-game, Post-game, and Follow-up phases.

[4] Due to the fact that testing the factorial structures of multi-dimensional scales is not one of the aim of the current study we don't report here the results.

based on tone, communicative intent, figures of speech, awareness during the walks, and symbolic relevance from culture of origin. Then, the dataset was analyzed again, with the two researchers discussing together their reasonings for the codes, including all shades of meaning derived from both lines of work, and checking constantly cultural biases, age and educational biases, and misunderstandings. To provide further transparency of the applied methodology, we reported an example below:

Taking the first open question: "Which stage of the game surprised you the most? And why?" the first four participants yielded the following answers.

1. **Discovering** how the building in the **square** is used.
2. The **old walled-up school**, because **I didn't know** there was a **school** there.
3. The **small houses behind** the Italo Stagno **school - I didn't know they existed**.
4. Overall, everything was **enjoyable**; **searching** for the **symbols** on the **buildings** was probably the **most fun part**.

For every answer it was necessary to highlight the landmarks, the adjectives, and the actions that resulted more evident at first glance.

1. **Discovering** how the building in the **square** is used.
2. The **old walled-up school**, because **I didn't know** there was a **school** there.
3. The **small houses behind** the Italo Stagno **school - I didn't know they existed**.
4. Overall, everything was **enjoyable**; **searching** for the **symbols** on the **buildings** was probably the **most fun part**.

The two paper co-authors then proceeded to extract the codes from each answer, while discussing at every step if each new addition to the codes was warranted or if existing codes could be utilized to greater efficiency.

1. Discovering how the building in the square is used: Exploration, Getting to know, Square, Sacripanti Core.
2. The old walled-up school, because I didn't know there was a school there: Popular School (×2), Not knowing.
3. The small houses behind the Italo Stagno school - I didn't know they existed: Small houses, Popular School, Not knowing.
4. Overall, everything was enjoyable; searching for the symbols on the buildings was probably the most fun part: Pleasantness (×2), Exploration, Game clues, Dwellings.

After the codes were extracted, further discussion among all members of the paper was conducted to ensure the redaction of biases, misunderstandings, and to round out the results into the final codebooks presented in Section 3.2 of this paper.

Once the codes were derived, aiming for theoretical saturation, the work consisted in finding the concepts that reflected the major aspects of these codes, semantically linking them together while considering the prevalence of the frequency of each individual code, which influenced the results. The two research team members (*GLP, AM*) reached an agreement in assigning codes, concepts, and categories, in iterative rounds, first individually and then confronting the results together, to gain a better understanding of the emerging theory while reducing individual biases. This analytic strategy allowed us to integrate qualitative insights with the quantitative results through a triangulation approach (Creswell, 2013; Denzin, 1978), where the reflective narratives were not treated as anecdotal but as a complementary lens for contextualizing, extending, or challenging patterns observed in the surveys. In this vein, the qualitative aspects that emerged from the sample were mostly used in relation to the quantitative data extracted from the questionnaire, to better contextualize said data: in other words, we opted for a data triangulation (Denzin, 1978) to better enrich the quality of the data gathered. Triangulation is a post-positivist methodological strategy employed in a mixed, or multimethod, approach to social inquiry (Creswell, 2013; Tashakkori & Teddlie, 2003). When the term "triangulation" was introduced in the social sciences, the method designated by it functioned as a bridge between quantitative and qualitative epistemologies, providing better inferences based on a greater diversity of divergent views (Tashakkori & Teddlie, 2003).

## 3. Results

### 3.1. Hypothesis testing

To analyze the normality of the distribution of the variables examined, descriptive statistics were computed (see Table 1). The analyses showed that the variables assume a tendentially normal distribution except for Negative Emotions.

With regard to Restorativeness (Fig. 3 and Table 2), Fascination did not change significantly among Time measurements, and we were not able to confirm H1a and H3a. Being Away [$F(2, 296) = 4.44$, $p < .05$, partial $\eta p2 = 0.03$] increases significantly only between Pre- and Follow-up ($p = .01$), confirming only H1b. This suggests that the perception of having broken up with a routine is not perceived immediately after the experience, but the sense of ease can be recalled after a certain time. Participants reported a significant increase between Pre and Post ($p = .00$), confirming H1c, and a decrease between Post and Follow-up ($p = .03$) in Coherence [$F(2, 296) = 12.17$, $p < .001$, partial $\eta p2 = 0.08$], disconfirming H3c; this means that the participants evaluated the experience as in line with their restorative aims only once the experience took place. Perception of architectural barriers (i.e., Scope) increases only from Pre to Post ($p = .00$) [$F(2, 296) = 7.00$, $p = .001$, partial $\eta p2 = 0.05$], confirming only H1d. This suggests that these barriers are well perceived after the experience.

As depicted in Fig. 4 and Table 3, Positive Emotions [$F(2, 294) = 7.36$, $p < .001$, partial $\eta p2 = 0.05$] increased between Pre and Post ($p = .00$) and Pre and Follow-up ($p = .00$), confirming H1e and partially H3e. Engagement [$F(2, 294) = 10.26$, $p < .001$, partial $\eta p2 = 0.07$] increased between Pre and Post ($p = .00$) and Pre and Follow-up ($p = .01$), confirming both H1f and H3f. Participants reported a significant increase between Pre and Post in Serendipity [$F(2, 294) = 4.33$, $p < .05$, partial $\eta p2 = 0.03$; $p = .00$], confirming only H1g. Creative Freedom did not significantly increase from Pre to Post, disconfirming H1h, but there was an increase from Post to Follow-up [$F(2, 294) = 3.04$, $p < .05$, partial $\eta p2 = 0.02$, $p = .02$], disconfirming also H3h. Finally, Negative Emotions [$F(2,294) = 4.39$, $p < .05$, partial $\eta p2 = 0.03$] increased between Pre and Post ($p = .00$), disconfirming H1i, and showed a tendency of decrease between Post and Follow-up ($p = .06$), disconfirming also H3i.

As shown in Table 4, the variables Storytelling, SSAG, and Social Connection showed significant correlations with almost all the variables considered in the study. In particular, they showed positive correlations with all the variables except two: Negative Emotions and Scope. This implies that negative emotions and architectural barriers (i.e., Scope) did not affect the Walklets experience at the Post-test. The strongest correlation shown by Storytelling was with Creative Freedom ($r = 0.68$, $p = .000$), closely followed by Serendipity ($r = 0.67$, $p = .000$). Other significant correlations observed with Storytelling included Coherence ($r = 0.59$, $p = .000$), Being Away ($r = 0.54$, $p = .000$), Fascination ($r = 0.54$, $p = .000$), Engagement ($r = 0.53$, $p = .000$) and Positive Emotions ($r = 0.46$, $p < p = .000$). Similarly, SSAG showed its strongest correlation with Creative Freedom ($r = 0.63$, $p = .000$), mirroring Storytelling. Other notable correlations observed with SSAG were Coherence ($r = 0.57$, $p = .000$, Being Away ($r = 0.53$, $p = .000$), Serendipity ($r = 0.45$, $p = .000$), Positive Emotions ($r = 0.38$, $p = .000$, Fascination ($r = 0.37$, $p = .000$), and Engagement ($r = 0.36$, $p = .000$). Social Connection also showed the strongest correlation with Creative Freedom ($r = 0.57$, $p = .000$), according to the other two variables. Other significant

**Table 1**
Descriptive statistics: mean, standard deviation, skewness, and kurtosis of the study variables.

| | Frequency | | Percent | | | | | |
|---|---|---|---|---|---|---|---|---|
| Education level | Junior High School Diploma | 6 | 5.6 | | | | | |
| | High School diploma | 65 | 60.2 | | | | | |
| | Bachelor's degree | 20 | 18.5 | | | | | |
| | Master's degree | 13 | 12 | | | | | |
| | Ph.D. | 4 | 3.7 | | | | | |
| Gender | Females | 54 | 50 | | | | | |
| | Males | 54 | 50 | | | | | |
| | | N | Min | Max | M | SD | | |
| | Age | 108 | 18 | 66 | 29.63 | 12.38 | | |
| Time | | N | Min | Max | M | SD | Skewness | Kurtosis |
| Pre | Fascination | 107[a] | 1.00 | 5.00 | 3.48 | 0.80 | −0.51 | 0.84 |
| | Being Away | 107 | 1.00 | 5.00 | 3.28 | 0.95 | −0.48 | −0.09 |
| | Coherence | 107 | 1.00 | 5.00 | 3.55 | 0.70 | −0.55 | 0.97 |
| | Scope | 107 | 1.00 | 5.00 | 3.39 | 1.21 | −0.51 | −0.56 |
| | Serendipity | 107 | 1.00 | 5.00 | 3.28 | 0.90 | −0.32 | −0.05 |
| | Creativity | 107 | 1.00 | 7.00 | 4.88 | 1.20 | −0.59 | 0.58 |
| | Positive Emotions | 107 | 1.00 | 5.00 | 2.74 | 0.86 | 0.20 | −0.11 |
| | Negative Emotions | 107 | 1.00 | 5.00 | 1.37 | 0.63 | 3.44 | 14.26 |
| | Engagement | 107 | 1.00 | 5.00 | 3.41 | 1.00 | −0.35 | −0.67 |
| Post | Fascination | 107 | 1.00 | 5.00 | 3.74 | 0.87 | −0.79 | 0.65 |
| | Being Away | 107 | 1.00 | 5.00 | 3.52 | 1.10 | −0.65 | −0.46 |
| | Coherence | 107 | 2.00 | 5.00 | 4.07 | 0.77 | −0.79 | −0.10 |
| | Scope | 107 | 1.00 | 5.00 | 4.00 | 1.18 | −1.33 | 1.11 |
| | Serendipity | 107 | 1.14 | 5.00 | 3.64 | 0.97 | −0.70 | −0.29 |
| | Creativity | 107 | 1.00 | 7.00 | 5.20 | 1.31 | −0.71 | 0.30 |
| | Positive Emotions | 107 | 1.00 | 5.00 | 3.17 | 1.03 | −0.01 | −0.61 |
| | Negative Emotions | 107 | 1.00 | 4.60 | 1.64 | 0.82 | 1.93 | 3.38 |
| | Engagement | 107 | 1.42 | 5.00 | 3.98 | 0.94 | −0.85 | −0.04 |
| Follow-up | Fascination | 82[b] | 1.00 | 5.00 | 3.51 | 0.84 | −0.64 | 0.69 |
| | Being Away | 82 | 1.00 | 5.00 | 3.70 | 0.88 | −0.39 | 0.24 |
| | Coherence | 82 | 1.00 | 5.00 | 3.78 | 0.84 | −0.64 | 0.97 |
| | Scope | 82 | 1.00 | 5.00 | 3.66 | 1.18 | −0.72 | −0.20 |
| | Serendipity | 82 | 1.14 | 5.00 | 3.44 | 0.89 | −0.43 | −0.20 |
| | Creativity | 82 | 1.00 | 7.00 | 4.73 | 1.56 | −0.49 | −0.25 |
| | Positive Emotions | 82 | 1.00 | 5.00 | 3.17 | 0.86 | −0.05 | −0.40 |
| | Negative Emotions | 82 | 1.00 | 4.10 | 1.45 | 0.61 | 2.25 | 5.65 |
| | Engagement | 82 | 1.00 | 5.00 | 3.77 | 0.82 | −0.55 | 0.27 |

[a] Note: One participant was excluded from analysis as he/she was identified as an outlier.
[b] Two participants were excluded from analysis as they were identified as outliers

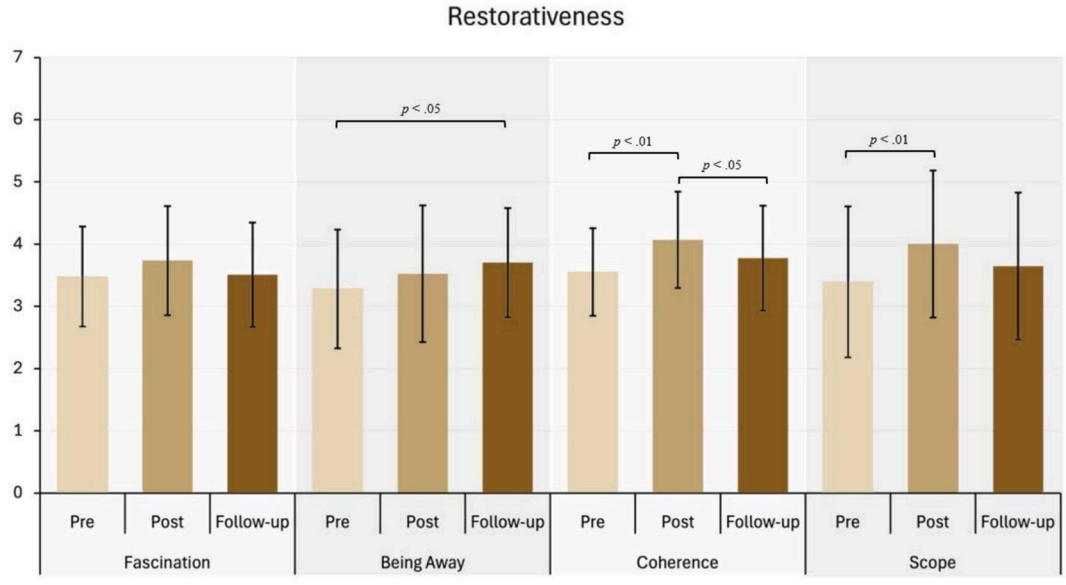


**Fig. 3.** ANOVAs with Restorativeness dimensions – Fascination, Being away, Coherence and Scope – as DVs and time measurement (Pre, Post, Follow-up) as IV.

**Table 2**
Post-hoc tests (Bonferroni) on Restorativeness dimensions.

| Dependent variable | Difference | | Difference in average | s.e. | *p* | 95 % confidence limits | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Fascination[a] | Pre | Post | −0.26 | 0.11 | 0.08 | −0.53 | 0.02 |
| | Pre | Follow-up | −0.03 | 0.12 | 1.00 | −0.33 | 0.27 |
| | Post | Pre | 0.26 | 0.11 | 0.08 | −0.02 | 0.53 |
| | Post | Follow-up | 0.23 | 0.12 | 0.20 | −0.07 | 0.52 |
| | Follow-up | Pre | 0.03 | 0.12 | 1.00 | −0.27 | 0.33 |
| | Follow-up | Post | −0.23 | 0.12 | 0.20 | −0.52 | 0.07 |
| Being away[a] | Pre | Post | −0.25 | 0.14 | 0.21 | −0.57 | 0.08 |
| | Pre | Follow-up | −0.43* | 0.15 | 0.01 | −0.78 | −0.08 |
| | Post | Pre | 0.25 | 0.14 | 0.21 | −0.08 | 0.57 |
| | Post | Follow-up | −0.18 | 0.15 | 0.65 | −0.53 | 0.17 |
| | Follow-up | Pre | 0.43* | 0.15 | 0.01 | 0.08 | 0.78 |
| | Follow-up | Post | 0.18 | 0.15 | 0.65 | −0.17 | 0.53 |
| Coherence[a] | Pre | Post | −0.52* | 0.11 | 0.00 | −0.77 | −0.26 |
| | Pre | Follow-up | −0.23 | 0.11 | 0.14 | −0.50 | 0.05 |
| | Post | Pre | 0.52* | 0.11 | 0.00 | 0.26 | 0.77 |
| | Post | Follow-up | 0.29* | 0.11 | 0.03 | 0.02 | 0.56 |
| | Follow-up | Pre | 0.23 | 0.11 | 0.14 | −0.05 | 0.50 |
| | Follow-up | Post | −0.29* | 0.11 | 0.03 | −0.56 | −0.02 |
| Scope[a] | Pre | Post | −0.61* | 0.16 | 0.00 | −1.00 | −0.22 |
| | Pre | Follow-up | −0.25 | 0.18 | 0.44 | −0.68 | 0.17 |
| | Post | Pre | 0.61* | 0.16 | 0.00 | 0.22 | 1.00 |
| | Post | Follow-up | 0.35 | 0.18 | 0.13 | −0.07 | 0.77 |
| | Follow-up | Pre | 0.25 | 0.18 | 0.44 | −0.17 | 0.68 |
| | Follow-up | Post | −0.35 | 0.18 | 0.13 | −0.77 | 0.07 |

[a] Response scale 1–5.
* $p < 0.5$

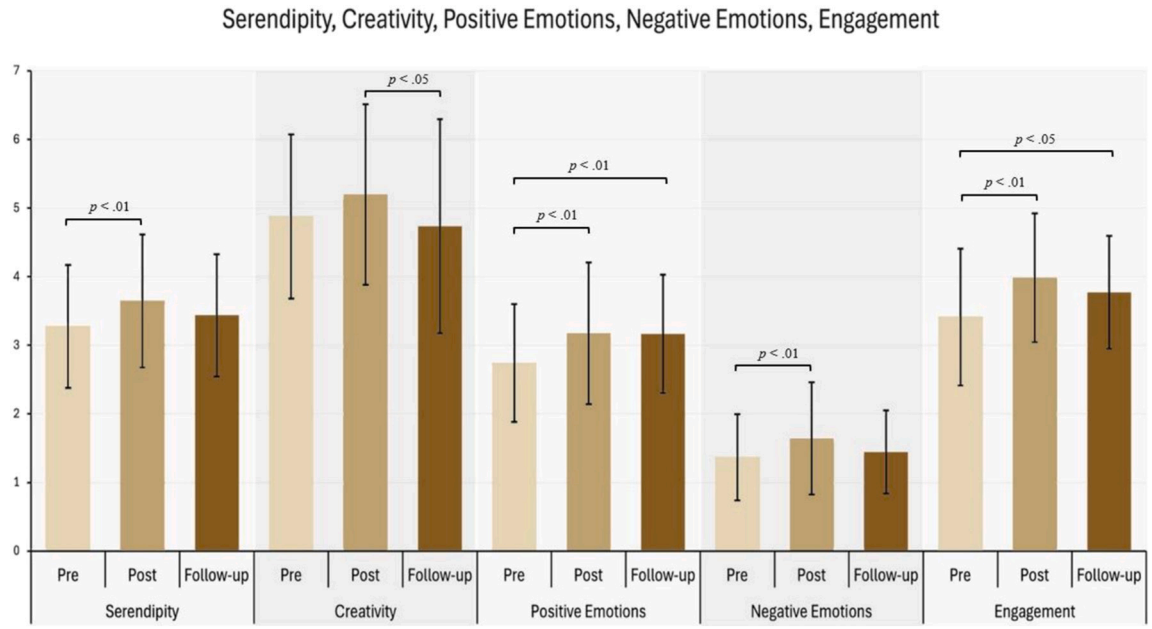


**Fig. 4.** ANOVAs with serendipity, creativity, emotionality, and engagement as DVs and time measurement (pre, post, follow-up) as IV.

correlations observed with Social Connection included Coherence ($r = 0.54, p = .000$), Being Away ($r = 0.46, p = .000$), Serendipity ($r = 0.37, p = .000$), Positive Emotions ($r = 0.34, p = .000$), Fascination ($r = 0.36, p = .000$), and Engagement ($r = 0.35$, $p = .000$). It emerged that Storytelling is the component more associated with restorative factors, positive emotions and engagement, and the constructs related to discovery, serendipity, and creative freedom.

### 3.2. Thematic analysis of qualitative data

The table below reports all the codes, concepts, and categories of the experience of the game, including a description of those qualitative data (see Appendix for a more detailed description of Table 5), followed by a discussion about them and their effective role in this research.

The codes and concepts described in the previous section can be grouped into broader categories:

- *Living the City*: Landmarks, City Sections, Pop Art, Sense of Community
- *Feeling the experience*: Walklets, Evaluations, Positive Emotions, Negative Emotions.
- *Acknowledging your place in the city*: Discovery, Introspection of Doubt, Biological Response.

**Table 3**
Post-hoc tests (Bonferroni) on serendipity, creative freedom, positive, negative emotions, and engagement dimensions.

| Dependent variable | Difference | | Difference in average | *s.e.* | *p* | 95 % confidence limits | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Serendipity[1] | Pre | Post | −0.37* | 0.13 | 0.00 | −0.62 | −0.12 |
| | Pre | Follow-up | −0.16 | 0.14 | 0.24 | −0.43 | 0.10 |
| | Post | Pre | 0.37* | 0.13 | 0.00 | 0.12 | 0.62 |
| | Post | Follow-up | 0.21 | 0.14 | 0.12 | −0.06 | 0.48 |
| | Follow-up | Pre | 0.16 | 0.14 | 0.24 | −0.11 | 0.43 |
| | Follow-up | Post | −0.21 | 0.14 | 0.12 | −0.48 | 0.06 |
| Creative Freedom[2] | Pre | Post | −0.32 | 0.18 | 0.08 | −0.69 | 0.04 |
| | Pre | Follow-up | 0.14 | 0.20 | 0.47 | −0.25 | 0.53 |
| | Post | Pre | 0.32 | 0.18 | 0.08 | −0.04 | 0.69 |
| | Post | Follow-up | 0.46* | 0.20 | 0.02 | 0.08 | 0.85 |
| | Follow-up | Pre | −0.14 | 0.20 | 0.47 | −0.53 | 0.25 |
| | Follow-up | Post | −0.46* | 0.20 | 0.02 | −0.85 | −0.08 |
| Positive Emotions[1] | Pre | Post | −0.43* | 0.13 | 0.00 | −0.68 | −0.18 |
| | Pre | Follow-up | −0.42* | 0.14 | 0.00 | −0.69 | −0.16 |
| | Post | Pre | 0.43* | 0.13 | 0.00 | 0.18 | 0.68 |
| | Post | Follow-up | 0.01 | 0.14 | 0.95 | −0.26 | 0.28 |
| | Follow-up | Pre | 0.42* | 0.14 | 0.00 | 0.16 | 0.69 |
| | Follow-up | Post | −0.01 | 0.14 | 0.95 | −0.28 | 0.26 |
| Negative Emotions[1] | Pre | Post | −0.28* | 0.10 | 0.00 | −0.46 | −0.09 |
| | Pre | Follow-up | −0.08 | 0.10 | 0.44 | −0.28 | 0.12 |
| | Post | Pre | 0.28* | 0.10 | 0.00 | 0.09 | 0.46 |
| | Post | Follow-up | 0.20 | 0.10 | 0.06 | −0.01 | 0.40 |
| | Follow-up | Pre | 0.08 | 0.10 | 0.44 | −0.12 | 0.28 |
| | Follow-up | Post | −0.20 | 0.10 | 0.06 | −0.40 | 0.01 |
| Engagement[1] | Pre | Post | −0.57* | 0.13 | 0.00 | −0.42 | −0.32 |
| | Pre | Follow-up | −0.36* | 0.14 | 0.01 | −0.63 | −0.09 |
| | Post | Pre | 0.57* | 0.13 | 0.00 | 0.32 | 0.82 |
| | Post | Follow-up | 0.21 | 0.14 | 0.12 | −0.06 | 0.48 |
| | Follow-up | Pre | 0.36* | 0.14 | 0.01 | 0.09 | 0.63 |
| | Follow-up | Post | −0.21 | 0.14 | 0.12 | −0.48 | 0.06 |

* $p < 0.5$

**Table 4**
Pearson's correlation matrix.

| | Story-telling | Satisfaction with Social Affordance of the Game (SSAG) | Social connection |
|---|---|---|---|
| Serendipity | 0.67*** | 0.45*** | 0.37*** |
| Creative freedom | 0.68*** | 0.63*** | 0.57*** |
| Positive emotions | 0.46*** | 0.38*** | 0.34*** |
| Negative emotions | 0.12 | −0.12 | −0.03 |
| Engagement | 0.53*** | 0.36*** | 0.35*** |
| Fascination | 0.54*** | 0.37*** | 0.36*** |
| Being away | 0.54*** | 0.53*** | 0.46*** |
| Coherence | 0.59*** | 0.57*** | 0.54*** |
| Scope | 0.14 | 0.14 | 0.10 |

Note: *** $p < .001$.

The first category, Living the City, refers to how participants engaged with the material and symbolic elements of the urban environment. It includes the concepts of Landmarks (e.g., references to specific places such as squares, benches, or former institutions), City Sections (broader urban areas such as Monte Claro Park or the Tuvixeddu necropolis), Pop Art (attention to urban details such as murals and architectural plates), and Sense of Community (codes referring to social belonging, justice, and shared memory). Together, these concepts highlight how the game fostered an exploration of both tangible and intangible aspects of the city.

The second category, Feeling the Experience, captures the emotional and experiential dimensions of the activity. It includes the concept of Walklets, which refers to the mechanics of the game itself (e.g., gaming, storytelling, physical activity, observation); Evaluations, encompassing reflections of uncertainty, disappointment, or inspiration; Positive Emotions, such as amazement, empathy, enthusiasm, or serenity; and Negative Emotions, including sadness and dread. This category illustrates how participants not only navigated the city but also developed a spectrum of emotional responses to the experience.

Finally, Acknowledging Your Place in the City emphasizes the personal and introspective processes involved in the activity. It comprises the concepts of Discovery (emerging from codes like curiosity, exploration, and serendipity), Introspection of Doubt (feelings of alienation, nostalgia, or reflection), and Biological Response (codes linked to embodied reactions such as agitation, adrenaline, or pain). This category reflects how the game prompted participants to situate themselves within the urban space, confronting personal emotions, bodily sensations, and reflective insights about their role in the city.

Through this layered process of coding, conceptualization, and categorization, the analysis was able to capture the complexity of participants' lived experience, balancing the external dimension of engaging with the city and the internal dimension of emotional and reflective responses.

On the emerging categories or themes, the experience of Walklets allowed the participants to "feel" for themselves the "pulse" of the city (*Feeling the experience*), the place of the Is Mirrionis neighborhood within the city (*Living the city*), but also their own place in the "city organism" (*Acknowledging your place in the city*) The experience also allowed participants to get a better grasp the history of the neighborhood, developing a more realistic sense of its chronology.

In the follow-up assessment, 84.5 % of participants, corresponding to 71 individuals, expressed interest in taking part in an activity like that conducted in the Is Mirrionis neighborhood, suggesting that the experience was satisfactory for the majority of participants. Additionally, 26.2 % (22 participants) independently re-visited the game locations, indicating further interest sparked by the activity.

Participants in the follow-up were further asked a series of questions about the Is Mirrionis neighborhood, to gather their perceptions after the game session. It is important to note that responses were evaluated on a scale from 1 (= not concerned at all) to 5 (= highly concerned).

**Table 5**
Codes and concepts results from thematic analysis.

| Codes | Frequency (%) | Concepts | Explanation |
|---|---|---|---|
| *Exploration* | 17 (16.83 %) | *Discovery* | Experiencing the world around and discovering it through this experience. |
| *Finding*[a] | 45 (44.55 %) | | |
| *Abandonment* | 12 (11.88 %) | | |
| *Serendipity* | 16 (15.84 %) | | |
| *Curiosity* | 10 (9.90 %) | | |
| *Mystery* | 1 (0.99 %) | | |
| Total | 101 (100 %) | | |
| *Square* | 1 (1.35 %) | *Landmarks* | Places of importance in the Is Mirrionis block that the participants viewed with interest and emotion. |
| *Workers' School* | 22 (29.73 %) | | |
| *Small Houses* | 2 (2.70 %) | | |
| *Small Barracks* | 23 (31.08 %) | | |
| *Ex Psych Ward* | 12 (16.22 %) | | |
| *Library* | 8 (10.81 %) | | |
| *The Bench* | 6 (8.11 %) | | |
| Total | 74 (100 %) | | |
| *Is Mirrionis* | 21 (31.82 %) | *City Sections* | Sections of the Is Mirrionis block or the city that the participants thought important enough to mention. |
| *Monte Claro Park* | 9 (13.64 %) | | |
| *Tuvixeddu* | 4 (6.06 %) | | |
| *Castle of San Michele* | 7 (10.61 %) | | |
| Via *Quirra Market* | 7 (10.61 %) | | |
| *Streets* | 8 (12.12 %) | | |
| *Sacripanti settlement* | 10 (15.15 %) | | |
| Total | 66 (100 %) | | |
| *INACASA Plates* | 13 (50.00 %) | *Pop Art* | Signs of the "lived in" city, whether proper art, or graffiti, or the city tiles of INACASA, that evoke a sense of cultural significance. |
| *Urban Detail* | 6 (23.08 %) | | |
| *Murals* | 7 (26.92 %) | | |
| Total | 26 (100 %) | | |
| *Gaming* | 13 (22.03 %) | *Walklet* | The full experience of the app, from the game to the real world components. |
| *Storytelling* | 37 (62.71 %) | | |
| *Observation* | 3 (5.08 %) | | |
| *Physical activity* | 6 (10.17 %) | | |
| Total | 59 (100 %) | | |
| *Uncertainty* | 1 (9.09 %) | *Evaluations* | Cognitive affects that developed during the experience. |
| *Compassion* | 2 (18.18 %) | | |
| *Disappointment* | 6 (54.55 %) | | |
| *Inspiration* | 2 (18.18 %) | | |
| Total | 11 (100 %) | | |
| *Upheaval* | 1 (5.26 %) | *Introspection of doubt* | Thoughts or feelings that brought doubt to the participant, allowing them to wonder about different aspects of life without an answer. |
| *Nostalgia* | 6 (31.58 %) | | |
| *Reflection* | 10 (52.63 %) | | |
| *Alienation* | 2 (10.53 %) | | |
| Total | 19 (100 %) | | |
| *Pleasure* | 54 (55.67 %) | *Positive Emotions* | Good and positive feelings that stayed with the participants during or after the experience. |
| *Amazement* | 22 (22.68 %) | | |
| *Empathy* | 4 (4.12 %) | | |
| *Enthusiasm* | 12 (12.37 %) | | |
| *Serenity* | 3 (3.09 %) | | |
| *Satisfaction* | 2 (2.06 %) | | |
| Total | 97 (100 %) | | |
| *Dread* | 3 (50.00 %) | *Negative Emotions* | Uncomfortable and negative feelings that stayed with the participants during or after the experience. |
| *Sadness* | 3 (50.00 %) | | |
| Total | 6 (100 %) | | |
| *Agitation* | 1 (14.29 %) | *Biological Response* | Physiological activations of body signals like pain, adrenaline, anxiety etc. |
| *Adrenalin* | 2 (28.57 %) | | |
| *Annoyance* | 2 (28.57 %) | | |
| *Pain* | 2 (28.57 %) | | |
| Total | 7 (100 %) | | |
| *Place Memory* | 41 (48.24 %) | *Sense of Community* | Feeling the shared experience of the Is Mirrionis block during this experience, the lives of its inhabitants and their struggles. |
| *Internalised homophobia* | 2 (2.35 %) | | |
| *Past* | 2 (2.35 %) | | |
| *Prejudices* | 7 (8.24 %) | | |
| *Community* | 32 (37.65 %) | | |
| *Justice* | 1 (1.18 %) | | |
| Total | 85 (100 %) | | |
| *TfN* | 20 (100 %) | *No Data* | Either incomprehensible, or senseless drivel, unusable phrases (if some can call it that way). |

[a] Third question excluded.

72.6 % (61 participants) expressed concern about the loss of open spaces; 77.4 % (65 participants) about air pollution due to transportation; 71.4 % (60 participants) about the health of flora; 73.8 % (62 participants) about the health of fauna; 78.6 % (66 participants) about the community's health in the neighborhood; and finally, 66.7 % (56 participants) about media news (newspapers, radio, TV, etc.). These data are interesting when interpreted in light of the following facts: 70.2 % (59 participants) of the sample have never lived in the neighborhood, and additionally, 65.5 % (55 participants) had no emotionally significant connection to it, while 59.5 % (50 participants) had never had any emotionally significant connection to the neighborhood. Ultimately, despite the lack of a strong bond with the neighborhood, the Walklets experience has elicited sensitivity toward the neighborhood's life in the majority of participants in our research.

## 4. Discussion

This study provides evidence that pervasive narrative-driven games can meaningfully influence participants' relationships with urban spaces. Quantitative analyses revealed short-term increases in positive emotions, engagement, and serendipity, echoing previous findings that playful walking interventions enhance restoration and social interaction (Hanson & Jones, 2015; Janeczko et al., 2020). However, effects often diminished at three-month follow-up, suggesting that while games can trigger powerful immediate responses, sustaining these effects may require repeated or embedded interventions, that is an issue also identified in evaluations of Pokémon Go (Chen, Lu, & Luor, 2018).

This study aimed to examine, through a mixed method approach, changes in attitudes and perceptions induced by the pervasive game *Walklets*, both immediately after the game session and then after three months, to detect, respectively, possible positive short-term and long-term effects of the game. We were able to accept H1 only partially: we contribute to the existing knowledge by exploring different variables related to people-place relationships, like emotions (H1e, H1i), engagement (H1f), and restorativeness (H1a-b-c-d), demonstrating the efficacy of the pervasive game in the majority of measured variables immediately after the experience. The restorative effects of *Walklets* emerged at the end of the game for the Coherence (H1c) and Scope (H1d) dimensions of restorativeness, through walks and social interactions with other players, in line with Janeczko et al. (2020) with their study on the relationship between urban walks and restorativeness, and Hanson and Jones (2015) on the restorative role of social interactions in walking groups. Fascination, the degree of how much a certain place with its aesthetic features can restore attention, was not

affected by *Walklets* (H1a), possibly because of the highly ambivalent and stigmatized nature of Is Mirrionis and San Michele context, which emerged by the post-game dialogues with participants. These characteristics influenced also the increase of negative emotions (H1i) and a not significant increase in Being Away (H1b), the possibility of breaking with the stress of daily life (Hartig et al., 1991). On the other hand, *Walklets* allowed for the increase of positive emotions, engagement, and serendipity levels (H1g); the latter, defined as the occurrence and development of events by chance happily or beneficially, is another key characteristic of *Walklets*, which encourages players to become deeply immersed in the game by offering possibilities of serendipitous encounters and discovery of different solutions to the same enigmas (Chen et al., 2018).

Regarding H2, we were able to confirm the majority of hypotheses (from H2a,b,c,e,f,g), except for some variables such as Scope (H2d) and Creative Freedom (H2h), while we did not register significant increases in the measured variables in the Follow-up compared to the Post-experience There was an inverted U-shape relationship among measurement times for the majority of variables: scores generally increased immediately after the experience and returned to the pre-test levels after three months. It is worth noting that comparisons across time measurements are different. Despite the general decline in effects detected with the questionnaires, at a qualitative level, the thematic analysis allowed investigation of the mnestic traces after three months of the investigated constructs in a more unstructured way because participants answered an open question. Building on the collected data and the emerging theory, we can discuss various aspects of the *Walklets* game experience and its influence on participants' interpretation and perception of the surrounding environment. The qualitative results deepen this picture. Participants highlighted exploration, discovery, and serendipity as key features, often linking them to heightened awareness of urban history and community narratives. These findings resonate with work on "playful urbanism" (Duarte & Álvarez, 2021) and placemaking, where games foster new symbolic interpretations of ordinary spaces (Apperley & Moore, 2019; Cresswell, 2014). Importantly, participants also reported negative or ambivalent emotions, such as abandonment or alienation, underscoring that games do not simply beautify place experience but can surface critical awareness of social realities. This aligns with calls in critical game studies to recognize games as sites of reflection as well as pleasure (Ash & Gallacher, 2011).

First and foremost, we can surmise that participants experienced a wide range of emotions and reactions during the game, as confirmed by the variety of codes attributed to their responses. The presence of codes such as "Exploration" ($n = 17$), "Discovery" ($n = 45$), and "Curiosity" ($n = 10$) underscores the desire to explore and discover new places and spaces within the game, while the mention of a code like "Abandonment" ($n = 12$) highlights awareness of issues of decay and abandonment in the surrounding environment. This range of reactions suggests that the game has elicited emotional and cognitive engagement from participants, influencing their perception of the city and its symbolic places. It is also important to emphasize the significance of the "Serendipity" code ($n = 16$), included within the concept of Discovery, which played a fundamental role in exposing participants to new perspectives with which to view the world.

The results suggest that the experience of *Walklets* not only allows participants to explore the city physically but also prompts them to reflect on the meaning and history of the places visited. This underscores the importance of understanding the city's historical and social context, as well as one's role within it. The concept of "Sense of Community", encompassing our code "Place Memory" ($n = 41$), indicates that participants have developed a sense of belonging and a greater awareness of the history and local community through the game experience. Additionally, the presence of concepts such as "Evaluations" and "Introspection of Doubt" suggests that the game has also prompted participants to critically reflect on their experiences and perceptions, bringing to light questions and uncertainties regarding their understanding of the city and their role within it.

Lastly, the concepts "Positive Emotions" and "Negative Emotions" indicate that the game experience has elicited various contrasting emotional reactions in participants, which can influence their overall perception of the experience. This highlights the importance of the category "Feeling the experience", which aptly describes the sense of emotional engagement that participants experienced during the activity. A particular mention should be made of the code "Pleasure" ($n = 54$), which highlights how many participants reported feeling positive emotions during the game, but also when recalling the game experience.

The qualitative component of the study was a structured qualitative complement to the quantitative findings, enabling a deeper understanding of the experiential, emotional, and interpretive dimensions of the *Walklets* intervention. Whereas the surveys quantify changes in restorativeness, serendipity, engagement, and emotions, the open-ended responses captured how participants made sense of the urban environment, the narrative, and their own role within it. By systematically analyzing these reflections through a transparent coding process and a rigorously constructed codebook, we aimed to reveal underlying interpretive patterns that cannot be accessed through numerical measures alone. This approach aligns with mixed-methods designs in environmental psychology and urban studies, where combining structured measurement with reflective accounts strengthens explanatory power and enhances the ecological validity of the findings (Chen et al., 2018; Sander et al., 2025; Subramanian, De Moor, Fiedler, Koniuch, & Janowski, 2023; Wang, Yang, Nijhuis, & van der Spek, 2025). In this sense, the qualitative component provides a scientifically grounded extension of the quantitative results. Moreover, the study required considerable scientific and logistical coordination: the field experiment was conducted across 18 separate group sessions, each involving 6 participants, and each session supervised by trained researchers to ensure consistent procedures and data quality. This operational structure underscores the methodological rigor of the urban, in-situ experimental design.

The absence of long-lasting quantitative effects does not reduce the value of the intervention. Rather, it highlights the potential of pervasive games as "catalysts" for temporary but memorable shifts in perspective. As qualitative accounts showed, mnestic traces persisted, with participants recalling pleasure, curiosity, and community connections months later. Such traces may act as seeds for longer-term place attachment if reinforced by additional activities or urban regeneration initiatives.

H3 was almost fully confirmed by the findings: all the study variables (except Negative Emotions) were positively associated with a positive evaluation of both the pervasive game features (i.e., storytelling and social affordances offered by the game) and social interactions that occurred during the experience (H3a to H3i). It emerged that storytelling is the component more associated with the dependent variables. Storytelling or narrative is commonly used in both digital entertainment and pervasive games to motivate players first and then keep them engaged (Pløhn, Louchart, & Aalberg, 2014). In the particular context of *Walklets*, the story represents an important game design element for the player's motivation and engagement, but also in terms of pervasiveness and immersion "in the shoes" of Vittoria, the main character of the game. Contrary to many games where competition is an essential element, *Walklets'* capacity to blend virtual and real presences is primarily motivated by the desire to achieve narrative immersion and create a consistent and persistent story world through which positive relationships with the neighborhood can be put into context and achieved dynamically, transforming every group walk into a unique adventure.

From a methodological standpoint, the findings also underscore the importance of narrative immersion. Storytelling emerged as the most consistent predictor of positive responses, supporting arguments that narrative is central to engagement in both entertainment and educational games (Pløhn et al., 2014). Future research should explore how different narrative designs - linear, branching, or co-created - shape

urban place experiences. Overall, this study contributes to debates in environmental psychology, urban studies, and game research by showing how pervasive games can both enhance and complicate relationships with disadvantaged neighborhoods. They invite participants to re-imagine the city not only as a place of play, but also as a space of memory, conflict, and transformation.

Despite the general positive effects of *Walklets*, some limitations should be acknowledged. One is the sample composition: the groups were composed mainly of students not living in the studied area. This prevented the investigation of place attachment and place identity, which are drivers favoring positive interactions with places. Additionally, reliance on self-reporting means our findings are based on subjective perceptions, possibly skewed toward under-reporting of negative emotions, and affected by social desirability bias linked to the presence of two team members during the experience. Finally, our study is a field experiment, where many variables were not under control, and this can limit the generalization of our results.

Returning to our main proposition, we can hardly claim to have conclusively demonstrated that the proposed game model of the pervasive game is especially apt to produce the effects on players. This, likely, is not something that can be demonstrated *ex-ante*, and can perhaps only be shown through concrete examples of games, such as the one we have developed for Is Mirrionis and San Michele neighborhood, and by testing players' reactions through studies, such as this one, to evaluate their actual impact. Hence, the effectiveness of such games is not a granted result, it does not flow mechanically from the affordances of the game model, but still largely hinges on purposeful, non-trivial, competent both creatively and technically, and inventive game design. After all, not all *Myst*-like games created *Myst*-like affective experience, to say the least.

That notwithstanding, we have achieved our primary proposition, as the findings presented here show that the *Walklets* game experience had a meaningful impact on how participants perceive and interpret the urban environment. This study sheds light, in this specific instance, on the cognitive and emotional aspects of exploring cities through playful, technology-driven experiences. We believe that pervasive games like *Walklets* can serve as tools for engaging in urban spaces, in the special way such games are capable of, by influencing spatial awareness and understanding, offering new ways to experience and reimagine places in a city, and perhaps sometimes developing special relationships with them.

## 5. Conclusion

This study examined how the pervasive game *Walklets* shaped participants' psychological responses to disadvantaged neighborhoods in the city of Cagliari (Region of Sardinia, Italy). By combining the outcomes from surveys and thematic analysis, we demonstrated that narrative-driven pervasive games can trigger short-term increases in restoration, serendipity, engagement, and emotional connection, while also surfacing ambivalent or critical reflections about urban decline and social stigma. Although quantitative effects often diminished after three months, qualitative accounts revealed that mnemonic and affective traces persisted, suggesting that even temporary interventions can seed longer-term transformations in place perception.

Our findings contribute to debates on how everyday practices and cultural technologies mediate relationships with urban environments. They align with the promotion of more "playable cities", which highlights how playful interventions can foster exploration, curiosity, and new interpretations of urban space (Nijholt, 2017; Innocent & Stevens, 2021). The results also extend environmental psychology frameworks such as Attention Restoration Theory (Kaplan, 1995), demonstrating that restorative benefits can emerge not only in natural settings, but also in socially complex urban neighborhoods when elicited through game narratives. By embedding local history and memory in gameplay, *Walklets* illustrates how storytelling can play the role of a key mechanism for deepening place attachment, thus echoing recent calls for narrative-based approaches to urban regeneration (Apperley & Moore, 2019; Duarte & Álvarez, 2021).

Similar to evidence from location-based games like Pokémon Go, which increased physical activity and reshaped urban mobility patterns (Althoff et al., 2016), our study suggests that pervasive games can support both physical and psychological well-being in urban contexts. This resonates with public health research linking playful walking interventions to reduced stress and enhanced community connection (Hanson & Jones, 2015; Janeczko et al., 2020). Importantly, participants in our study reported not only enjoyment but also critical engagement with themes of abandonment, exclusion, and community resilience—suggesting that games can stimulate reflection as well as pleasure.

For urban planners, designers, and policymakers, these findings highlight the potential of pervasive games as low-cost, participatory tools to re-engage residents with stigmatized or underutilized neighborhoods. By activating local narratives and fostering playful exploration, such interventions may complement regeneration strategies, contribute to community-based planning, and enhance urban inclusivity. However, realizing these potentials requires sustained engagement strategies and iterative collaboration with local communities to avoid short-lived effects or externally imposed narratives.

Our study was limited by a student-dominated, non-representative sample, a single-session design, and reliance on self-reported measures. Future research should broaden recruitment to include residents, employ longitudinal or repeated-intervention designs, and adopt more sophisticated statistical models that control individual-level variation. Further, comparative research across different neighborhoods and cities would help identify how socio-spatial context interacts with game design to shape outcomes.

Despite these limitations, this research shows that pervasive games can serve as more than entertainment: they are emerging urban practices that bridge storytelling, exploration, and community experience. By reactivating attention, curiosity, and affect in neglected environments, such games can help residents and visitors alike to "see the city anew." In doing so, they open up novel pathways for participatory, experiential, and inclusive approaches to urban regeneration with innovative ways of understanding and transforming the urban condition.

## CRediT authorship contribution statement

**Oriana Mosca:** Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Writing – review & editing, Writing – original draft. **Ferdinando Fornara:** Supervision, Project administration, Methodology, Conceptualization, Writing – review & editing, Writing – original draft. **Gabriele Luigi Pia:** Methodology, Investigation, Formal analysis, Data curation, Writing - original draft. **Vanessa Pinna:** Investigation, Data curation, Writing – original draft. **Andrea Manunza:** Investigation, Formal analysis, Data curation, Writing – review & editing, Writing – original draft. **Carla Salis:** Investigation, Data curation, Writing - original draft. **Lucio Davide Spano:** Supervision, Software, Project administration, Writing – review & editing. **Emanuel Muroni:** Visualization, Methodology, Writing – original draft. **Ivan Blečić:** Supervision, Software, Project administration, Methodology, Conceptualization, Writing – review & editing, Writing – original draft.

## Declaration of competing interest

We have no conflicts of interest to disclose.

**Table A1**

| Codes | Concepts |
|---|---|
| *Exploration: x17*<br>The act of experiencing a new space.<br>*Finding: x45 (Third Question Excluded)*<br>Realizing the existence of new places, spaces, things, people.<br>*Abandonment: x12*<br>Noticing the decay, abandonment, and misuse of public spaces and/or landmarks.<br>*Serendipity: x16*<br>A new paradigmatic shift in prospective about something previously known.<br>*Curiosity: x10*<br>The feeling of curiosity, of being drawn to unknown places.<br>*Mystery: x1*<br>The feeling of the unknowable. | *Discovery (total number of codes = 101)*<br>Experiencing the world around and discovering it through this experience. |
| *Square: x1*<br>*Folk School: x22*<br>*Small Houses: x2*<br>*Small Barracks: x23*<br>*Ex Psych Ward: x12*<br>*Library: x8*<br>*The Bench: x6* | *Landmarks (total number of codes = 74)*<br>Places of importance in the Is Mirrionis block that the participants viewed with interest and emotion. |
| *Is Mirrionis: x21*<br>*Monte Claro Park: x9*<br>*Tuvixeddu: x4*<br>*Castle of San Michele: x7*<br>Via *Quirra Market: x7*<br>*Streets: x8*<br>*Sacripanti settlement.: x10* | *City Sections (total number of codes = 66)*<br>Sections of the Is Mirrionis block or the city that the participants thought important enough to mention. |
| *INACASA Plates: x13*<br>*Urban Detail: x6*<br>An interesting detail of small importance in the grand scheme of the city, but notable by the participant.<br>*Murals: x7* | *Pop Art (total number of codes = 26)*<br>Signs of the "lived in" city, whether proper art, or graffiti, or the city tiles of INACASA, that evoke a sense of cultural significance. |
| *Gaming: x13*<br>The "mechanics" of the Walklets game, the puzzles and maps and challenges.<br>*Storytelling: x37*<br>The narrative endeavor of the story presented in the walklets, and how much it resonated with the participants. | *Walklet (total number of codes = 59)*<br>The full experience of the app, from the game to the real world components. |
| *Observation: x3*<br>Moments of respite and pure observational acumen.<br>*Physical activity: x6*<br>Notable remarks of the walking, jogging, jumping, the physical realm of the experience. | |
| *Uncertainty: x1*<br>Difficulty to understand how to process the experience.<br>*Compassion: x2*<br>A show of empathy and sympathy that is reasoned and genuine.<br>*Disappointment: x6*<br>Disappointment about certain parts of the experience (mainly the knowledge that the story of the game is fabricated).<br>*Inspiration: x2*<br>Ideas sparked in response to the experience. | *Evaluations (total number of codes = 11)*<br>Cognitive affects that developed during the experience. |
| *Upheaval: x1*<br>Shock and turmoil provoked by the knowledges acquired during the experience.<br>*Nostalgia: x6*<br>Feelings of nostalgia provoked by certain sights in the experience.<br>*Reflection: x10*<br>Introspections about the game, life, or something else, related, and unrelated to the experience. | *Introspection of doubt (total number of codes = 19)*<br>Thoughts or feelings that brought doubt to the participant, allowing them to wonder about different aspects of life without an answer. |

(*continued on next column*)

**Table A1** (*continued*)

| Codes | Concepts |
|---|---|
| *Alienation: x2*<br>Feeling of being a stranger in a strange land, or a stranger in their own perspective. | |
| *Pleasure: x54*<br>Feelings that are pleasurable and happy.<br>*Amazement: x22*<br>Feelings of surprise and wonder.<br>*Empathy: x4*<br>Acts or feelings of empathy.<br>*Enthusiasm: x12*<br>Displays of powerful participation related to the experience.<br>*Serenity: x3*<br>Calm and peace brought by the experience.<br>*Satisfaction: x2*<br>Feelings of accomplishment and *fiero*. | *Positive Emotions (total number of codes = 97)*<br>Good and positive feelings that stayed with the participants during or after the experience. |
| *Dread: x3*<br>Feelings of dread and danger.<br>*Sadness: x3*<br>Feelings of sadness or anguish. | *Negative Emotions (total number of codes = 6)*<br>Uncomfortable and negative feelings that stayed with the participants during or after the experience. |
| *Agitation: x1*<br>Anxiety and "twitchiness".<br>*Adrenalin: x2*<br>Excitement and thrill after certain parts of the experience.<br>*Annoyance: x2*<br>Uncomfortableness brought by physiological reactions.<br>*Pain: x2*<br>Pain experienced during the long walks. | *Biological Response (total number of codes = 7)*<br>Physiological activations of body signals like pain, adrenaline, anxiety etc. |
| *Place Memory: x41*<br>Place memory, the participants' recognition of the history, stories, and lives in the places.<br>*Internalised homophobia: x2*<br>Implicit denial about the existence of queerness.<br>*Past: x2*<br>Mentions of the distant past.<br>*Prejudices: x7*<br>Recognition of the harmful effects of prejudice and the dislike of it.<br>*Community: x32*<br>The experience shared between friends and colleagues, but also the bonds developed to the place and the other participants.<br>*Justice: x1*<br>The stated desire to do something to help right systemic oppression. | *Sense of Community (total number of codes = 85)*<br>Feeling the shared experience of the Is Mirrionis block during this experience, the lives of its inhabitants and their struggles. |
| *TfN: 20*<br>*Acronym for: Thanks for Nothing*<br>Either incomprehensible, or senseless drivel, unusable phrases (if some can call it that way). | *No Data (total number of codes = 20)* |

## Data availability

Data will be made available on request.

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