Situated Artifacts Amplify Engagement in Physical Activity

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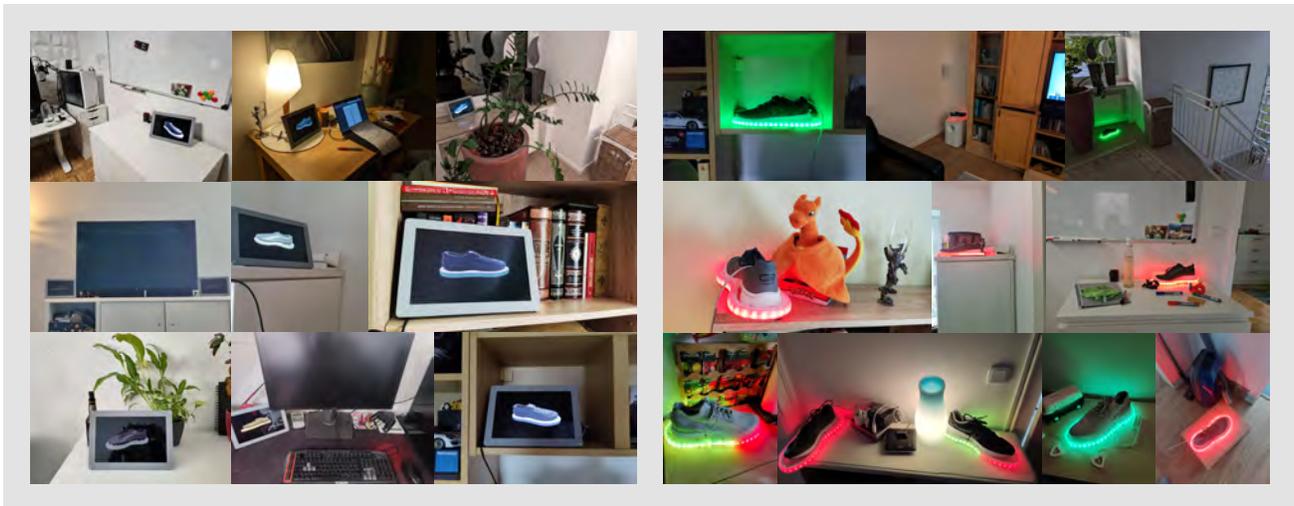Essen, Germany
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Figure 1: Digital and Physical Situated Artifacts showing the progress towards users' daily physical activity goal. The collage shows the placement of the artifacts in participants' homes during the 9-week field study for a subset of the 24 participants who optionally took a photo and gave their consent for publication.

Abstract

In the context of rising sedentary lifestyles, this paper investigates the efficacy of "Situated Artifacts" in promoting physical activity. We designed two artifacts that display users' physical activity data within their homes – one physical and one digital. We conducted a 9-week, counterbalanced, within-subject field study with $N = 24$ participants to assess the impact of these artifacts on physical activity, reflection, and motivation. We collected quantitative data on physical activity and administered daily and weekly questionnaires, employing individual Likert items and standardized instruments, as well as conducted interviews post-prototype usage. Our findings indicate that while both artifacts act as reminders for physical activity, the physical artifact was superior in terms of user engagement. The study revealed that this can be attributed to the higher perceived presence and, thereby, enhanced social interaction, which acts as a motivational source for activity. In this sense, situated artifacts gently nudge toward sustainable health behavior change.

CCS Concepts

• **Human-centered computing** → *Human computer interaction (HCI)*; Ubiquitous and mobile devices; • **Applied computing** → **Consumer health**.

Keywords

situated artifacts, physical activity, motivation, self-reflection, field study

1 Introduction

In recent decades, sedentary lifestyles, characterized by insufficient physical activity,[1] have significantly increased [45, 51], driven by societal and technological changes such as more screen-based work, leisure activities, and increased automobile use [45]. A 2024 study analyzing data from 2000 to 2022 across 197 countries revealed an increase in adult insufficient physical activity from 23.4% in 2000, over 26.4% in 2010, to 31.3% in 2022 [52]. Sedentary behavior is linked to higher risks of cardiovascular disease, type 2 diabetes, and musculoskeletal disorders [35, 45], leading to substantial societal costs [23], while sufficient physical activity offers mental health benefits, enhances well-being, and improves cognitive functions [35]. Intrinsic motivation alone may not suffice to increase physical activity, prompting the development of tools like active tracking [57, 58] and gamification [61]. There is also debate over whether physically situated artifacts might serve as better motivators [39], although their effectiveness remains unclear.

The American Heart Association and the WHO[1] recommend a weekly activity target equivalent to 150 Heart Points, or 20 per day, achievable through activities like 20 minutes of walking or 10 minutes of high-intensity exercise. Fitness tracking apps, such as Fitbit[2], Garmin Connect[3], and Google Fit[4], display users' goals and progress. The number of health-related apps has surged, with 90,000 new apps published in 2020, totaling over 350,000 [1]. These apps aim to increase physical activity by tracking and displaying it and sending notifications. However, users often ignore this data, especially when overwhelmed by notifications, or they may abandon the apps entirely [22, 34]. Thus, mobile notifications may not be the best method for sustaining activity awareness. Data physicalization, which converts abstract data into tangible objects [38], can enhance engagement [25]. Drawing inspiration from these concepts, *"Situated Artifacts"* – decorative objects in users' homes displaying personal data – facilitate engagement [11] and can motivate physical activity by representing data in meaningful forms [65].

We explored situated artifacts by creating two prototype data visualizations based on survey results about design, size, placement,

and light patterns. These artifacts, designed to visualize daily Heart Points relative to user-defined goals, were made as similar as possible, differing mainly in the presentation medium. One artifact is a *Physical Situated Artifact*, a "real shoe" (see Figure 1, right), while the other is a *Digital Situated Artifact*, a "picture frame" displaying the shoe (see Figure 1, left). We evaluated how the presentation medium impacts users' physical activity, motivation, motivational sources (Fitness Tracker and Apps, Situated Artifact, Social, other), and their self-perception, reflection, and feelings. Our research question: **(RQ) How does the presentation medium (physical vs. digital) affect a situated artifact's ability to motivate users?** We conducted a nine-week counterbalanced, within-subject field study with 24 participants, using fitness trackers and smartphones, and including daily and weekly questionnaires and two semi-structured interviews per participant after using the prototypes. The timeline included three weeks for each condition: baseline, digital artifact, and physical artifact, with artifacts placed in participants' homes perceivable in their everyday lives. Results showed a preference for the physical artifact, with higher willingness for continued use. We also gained insights into placement preferences and emotional associations with the artifacts. Our findings suggest that situated artifacts are a promising method for enhancing motivation for physical activity and enabling behavior change.

Contribution: Our contribution includes (1) the design and implementation of two situated artifacts – a physical shoe-shaped artifact and a digital artifact with a screen inside a picture frame –both displaying users' daily physical activity, and (2) the comprehensive results of a nine-week field study evaluating these artifacts' potential to motivate users and influence their everyday behavior.

2 Related Work

Physical activity holds profound health benefits, as numerous studies have underscored its transformative effects. For instance, even low-intensity activities, such as walking, yield significant improvements in cardiovascular health [42] while also serving as a bulwark against various diseases, blood pressure issues, and unwanted weight gain [12]. Furthermore, beyond physical well-being, regular physical activity emerges as a therapeutic force, alleviating symptoms of depression and anxiety [28] and catalyzing an uptick in overall mood and happiness [62]. In contrast, sedentary lifestyles are linked to numerous adverse health outcomes, harming both physical and mental well-being [59, 63].

2.1 Motivational Tools for Physical Activity

Ensuring consistent engagement in physical activities remains a formidable challenge despite the clear benefits they offer. Various innovative approaches to motivate individuals have emerged over time. One such avenue is the domain of persuasive design, a principle highlighted by Fogg's Behavior Model [20]. Fogg posits that motivation, ability, and a trigger must simultaneously converge for a behavior to manifest. This model provides valuable insights into human behavior and is seminal in the design of technologies aiming to drive specific actions.

Smartphone applications represent a typical approach within persuasive technologies, utilizing various methods to engage users. Previous work explored the possibilities of apps, e.g. by sending daily adaptive mini-dialogues and visual graphs to users' mobile

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[1]World Health Organisation, https://www.who.int/news-room/fact-sheets/detail/physical-activity, last visited on 2026–03–08.

[2]Fitbit, https://www.fitbit.com, last visited on 2026–03–08.

[3]Garmin, https://connect.garmin.com, last visited on 2026–03–08.

[4]Google Fit, https://www.google.de/fit, last visited on 2026–03–08.

phones to promote reflection, which has been shown to lead to increased motivation, empowerment, and adoption of new behaviors [32]. Further, Alqahtani et al.'s application adapts physical activity goals based on users' confidence levels to encourage regular reflection on and adjustment of goals [2]. Murnane et al.'s app employs narrative techniques to provide feedback, using the smartphones as ambient displays that visually encode tracked activities and progress towards goals [43].

Previous work extends the diversity of feedback modalities beyond typical auditory or visual notifications to include tactile and hybrid methods, broadening the sensory engagement with users [13]. Moreover, the granularity and type of metrics displayed are crucial in tailoring the personal informatics experience. Research has explored how derived metrics, such as health scores, can be optimally designed to enhance user interaction and comprehension [6].

But beyond mobile applications, the design space for motivational tools is expansive. An analysis of reflection support systems has delineated the broader design space, examining past research prototypes and apps that foster reflection through various interaction techniques. Bentvelzen et al.'s work identifies four primary design resources for reflection: temporal perspective, conversation, comparison, and discovery, each offering ways to motivate users [7].

2.2 Data Physicalization

Data physicalization, representing data as tangible, physical artifacts, is an embodiment of Fogg's principles [20] and can incorporate Bentvelzen et al.'s design ressources. As Jansen et al. elucidate, these artifacts are objects where the "geometry or material properties encode data" [26]. The strength of data physicalizations lies in their ability to harness the full spectrum of human perception, offering an experience beyond mere visual cues [26] and filling a broader design space [4]. Previous work found applications in varied fields, from distilling complex scientific data [24, 26] to fostering introspective journeys [21]. Their versatility extends to sharing data with others [17] and fostering self-analysis paradigms such as the quantified self movement [55]. Drawing from the work of Consolvo et al., there's an understanding of how technology design can cater specifically to encourage physical activity [14]. Moere and Purchase further categorize these physicalizations, with notable mentions like ambient display, pixel sculptures, and object augmentation [41]. Stusak et al.'s investigation into "activity sculptures" underscores the motivational potential of such tangible data representations [54]. The profound influence of emotional design, as articulated by Norman, further contextualizes these explorations [44]. Emotions play a pivotal role in human-object interactions. Therefore, designing with an emotional focus data physicalization can enhance user engagement.

Focusing on the topic of data physicalization on physical activity data, the goal is to present users with tangible representations of their activity levels. In this vein, Eslambolchilar et al. provided children and adolescents with 3D-printed models that represented their weekly physical activity levels. This approach was found to evoke a rich tapestry of experiences including embodied reflection, active learning, emotional engagement, and an enhanced temporal awareness [18]. Adding a playful dimension to data physicalization, Khot et al. transformed physical activity data into 3D-printed

chocolates [29] and fountain-mixed sports drinks [31], using food-based technology to enhance enjoyment and engagement. However, these examples illustrate static physicalizations, capturing data at a single point in time, while dynamic physical activity data, reflecting real-time changes, requires adaptive solutions. Menheere et al. addressed this with a shape-changing interface that adapts to represent changing activity data [40]. Similarly, LOOP provides an abstract visualization of activity data via a physical artifact that changes shape in real time [47], while De Haan et al. [16] created a shape-changing hanger that encourages users to grab their exercise clothing. Rogers et al. studied pervasive displays tracking stair versus elevator use to encourage physical activity, finding increased stair use across groups, though individuals were unaware of their behavior changes [46]. However, the authors recommend investigating this topic at the individual level, as their findings were based on data aggregated from all building users.

Despite these advancements, a significant research gap remains: the comparative efficacy of physical artifacts in user environments versus digital representations like smartphone apps, fitness trackers, or ambient displays is underexplored. It is still unclear if emotionally evocative situated artifacts, inspired by the concept of data physicalization, can better sustain engagement than digital alternatives. Additionally, there is a lack of long-term field studies to assess these interventions in real-world settings over extended periods.

3 Designing Situated Artifacts

In this section, we inform and guide the design of an ambient system for motivating physical activity in users' homes. To achieve that, we conducted an online survey as our Design Survey (DS) with $N_{DS} = 25$ participants. Our approach to designing these situated artifacts centers on enhancing users' self-reflection of their daily physical activity and motivating them to reach their activity goals, ultimately leading to changes of habits and nudging toward long-term behavior change in the future. The survey focused on identifying key aspects of a situated artifact designed to encourage physical activity. We explored which objects users associate with sports, placement, size, and specific design features for displaying activity levels.

3.1 Participants of the Design Survey

We recruited $N_{DS} = 25$ participants online through university mailing lists with ages ranging from 20 to 59 years ($M = 28.56$). Among the participants, 8 identified as female, 16 as male, and one preferred to not disclose their gender. All participants of this Design Survey were German-speaking, and we included all complete responses without applying further exclusion criteria.

3.2 Results of the Design Survey

3.2.1 Associated Objects. First, we explored what object the situated artifact should resemble. Since we strived to design a system that motivates users to be physically active, the design goal was that the situated artifact reminds users of a physical activity they like to perform. Thus, we asked participants about their physical activities and objects they associate with them. Participants engaged in an average of 2.8 different physical activities per week. When asked about objects they associated with their respective sports, 34.28% of

participants mentioned shoes. The association between sports and specific objects was explored, and while most associations were sport-specific, sports shoes emerged as a universally associated object across different sports. This finding supports the notion that sports shoes are promising design elements for situated artifacts aimed at promoting physical activity.

3.2.2 Artifact Location. Participants were asked to consider where they would place the motivating artifact in their homes. Overall participants mentioned seven distinctive locations. Common choices included tables and shelves in the home office, living room, kitchen, or hallway, emphasizing the need for a location that is both noticeable and unobtrusive. This diversity underscores the importance of allowing users to choose the placement themselves, as different users have distinct preferences and living arrangements.

3.2.3 Artifact Size. After selecting their preferred locations, participants specified their preferred artifact size, with most favoring dimensions between 20 and 30 cm, indicating a preference for compact to moderately sized artifacts. A shoe aligns well with this size preference, linking back to objects associated with physical activity.

3.2.4 Pattern Understandability and Preferences. We then explored how to communicate activity status to users. Three light patterns were presented to participants for interpreting physical activity goals: a binary pattern (red to green), a level pattern (red to green via orange and yellow), and a loading bar pattern (progression from red to yellow to green). Participants generally understood the binary and bar patterns, while some found the level pattern confusing. Overall, the bar pattern was the most favored.

3.3 Implementation of Prototypes and Devices

Based on these findings of our Design Survey, we created and implemented two prototype data visualizations: a *Physical Situated Artifact* and a *Digital Situated Artifact*.

3.3.1 Displayed Information. The situated artifacts aimed to provide motivational feedback on users' physical activity. We chose Heart Points as the metric, aligning with the WHO and American Heart Association's suggested weekly goal of 150 Heart Points, or about 20 per day[5]. Each minute of moderate activity contributes one Heart Point, while vigorous activity earns two, based on heart rate: 50% to 69% of maximum for moderate and 70% or higher for vigorous. Maximum heart rate is calculated by the formula: $205.8 - (0.685 * age)$. This metric is available via fitness apps such as Samsung Health[6] and Google Fit[7]. We implemented an Android application that collects the Google Fit data and pushes them to a Firebase[8] cloud service making them available for both artifacts.

3.3.2 Physical Situated Artifact - Hardware and Software Realization. The hardware realization of the physical situated artifact is shown in Figures 2d to 2f. We used gender-neutral sports shoes in subdued colors, with laser-cut and 3D-printed frames and baseplates as cases. Core components were an ESP32 microcontroller inside the shoe

and an LED strip within the 3D-printed frame. The ESP32 controlled the LEDs and calculated activity goals by accessing the Firebase cloud via WiFi to retrieve daily heart points. It then translated these into a light pattern based on a preset goal. Based on the design survey, the light pattern transitioned from red to yellow to green as a progress bar, depending on the user's progress. If a network error occurred, the shoe would light up blue, prompting the user to restart the system.

3.3.3 Digital Situated Artifact - Hardware and Software Realization. To make the digital version as similar as possible to the physical one, we used Unity to create an application displayed on a Samsung Galaxy Tab S4 tablet shown in Figures 2a to 2c. This digital version replicated the physical artifact's appearance and functionality, providing a 3D model of the shoe while limiting interaction to swiping to rotate it. The app also handled the calculation of activity goals and displayed progress using the same color communication pattern as the physical situated artifact. We positioned the tablet within a 3D-printed picture frame to enable its placement on a shelf akin to a traditional picture frame while discouraging any interaction with the tablet other than its intended use as a situated artifact or situated display [27, 50].

4 Evaluating Situated Artifacts

We conducted a 9-week within-subject field study to assess the motivational impact of a situated artifact's physical nature, comparing two presentation mediums: "physical" and "digital." A baseline phase at the start helped control for factors like the influence of fitness trackers, tracking apps (e.g., Google Fit), and participants' baseline motivation and self-reflection in daily life. We detail our research questions, study design, procedure, and results below.

4.1 Research Questions

Using the two prototypes of *Situated Artifacts*, we examine our main research question **(RQ) How does the presentation medium (physical vs. digital) affect a situated artifact's ability to motivate users?** We state related sub-questions to understand situated artifacts more thoroughly:

RQ_1 How does the presence of a situated artifact influence engagement in fitness trackers and apps, enhance social interactions about physical activity, and potentially contribute to change of habits?

We aim to explore if (a) the engagement in fitness trackers and apps declines for both artifacts, (b) users are less reminded by their trackers to be active, (c) users look at the physical artifact more frequently than at the digital artifact, (d) users are more reminded to be active by the physical than the digital artifact, and (e) the physical artifact evokes more social influence than the digital artifact.

RQ_2 How does the presentation medium affect the users' awareness of physical activity and reflection?

Our study investigates to which level the physical artifact outperforms the digital artifact with regard to (a) elicited feelings, (b) improved self-reflection, (c) user experience, and (d) self-awareness of physical activity.

RQ_3 How does the presentation medium influence the actual and perceived physical activity levels and motivation?

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[5]Google Heart Points https://support.google.com/fit/answer/7619539?hl=en&co=GENIE.Platform%3DAndroid, last visited on 2026−03−08.

[6]Samsung Health https://www.samsung.com/de/apps/samsung-health/, last visited on 2026−03−08.

[7]Google Fit https://www.google.de/fit, last visited on 2026−03−08.

[8]Firebase https://firebase.google.com/, last visited on 2026−03−08.

(a) Digital Artifact - No Heart Points   **(b) Digital Artifact - 50% Achieved**   **(c) Digital Artifact - 100% Achieved**

(d) Physical Artifact - No Heart Points   **(e) Physical Artifact - 50% Achieved**   **(f) Physical Artifact - 100% Achieved**
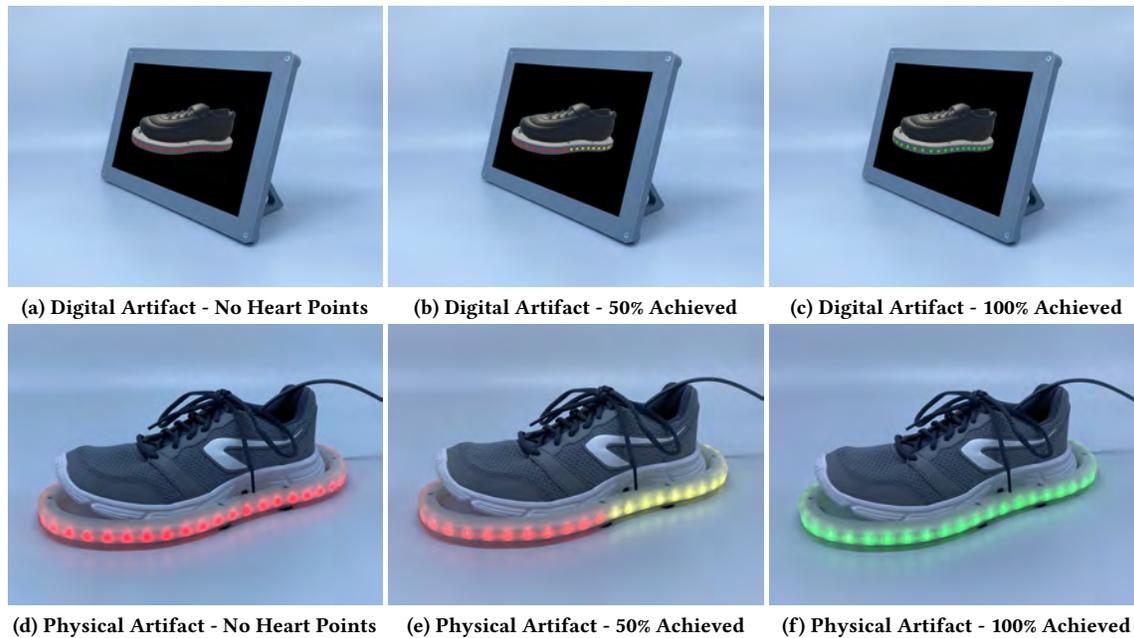
Figure 2: Images illustrating (a-c) digital and (d-f) physical prototypes across various daily states, demonstrating: no Heart Points collected yet, half of the daily Heart Point goal achieved, and full Heart Point goal reached.

Our objective is to analyze to what extent the physical artifact leads to (a) more physical activity, (b) the feeling of being more active, and (c) stronger motivation compared to the digital artifact. Further, we investigate if (d) the physical artifact more strongly amplifies other motivational sources compared to the digital artifact.

RQ_4 How does the presentation medium influence the users' willingness to use the situated artifact in everyday life?

We aim to explore whether users prefer the physical artifact over the digital counterpart.

4.2 Participants

We invited $N = 24$ participants (8 identified as female, 16 as male; aged between 22 and 65; $M = 31.58, SD = 10.74$) for our study. Participants' height ranged from 163 to 196 cm ($M = 176.04, SD = 8.68$), and their weight ranged from 47 to 110 kg ($M = 81.04, SD = 15.91$). Participants were not re-invited from the prior design survey but recruited independently via university mailing lists and social media. They were compensated with up to 75€ based on fulfilling the various measurements (see Figure 3). Half of the 24 participants were couples (6 couples living together and experiencing the same study conditions simultaneously), while the remaining 12 participated solo, either living alone or with non-participating cohabitants. Each participant received their own personalized artifact; couples received their artifacts at the same time and under the same counterbalanced condition (physical vs. digital), allowing for potential social effects while maintaining individual-level measurements (e.g., Heart Points), which were displayed separately on each participant's individual artifact. This pairing strategy was used to balance competitive effects from direct comparison within households on the overall outcomes. Participants' home office status was self-reported as the number of days per week spent working from home and ranged from 0 to 7 days ($M = 3.18, SD = 1.74$).

4.3 Tracked Data and Measuresments

Our study design integrates various measures to cover a broad range from data recordings over questionnaires to interviews. Figure 3 provides an overview of the procedure and times of assessment.

Objective Measures. We collected participants' heart points, movement minutes, and distances traveled per day using the Google Fit API. *Heart points* reflect every minute of moderate physical activity (one point) and vigorous activity (two points). *Movement minutes* count the daily minutes when the user is active, including walking, cycling, sports, or any activity producing at least 30 steps in 60 seconds (e.g., dancing, housework). *Distance traveled* measures the distance covered by foot, bike, or other modes requiring physical effort, based on acceleration and location changes.

Subjective Measures. The subjective measures include questionnaire responses. Appendix A provides an overview of questions asked, grouped into daily and weekly. The daily questionnaire included the Daily Motivation Baseline (DMB – Section A.2) and the Daily Motivation Conditions (DMC – Section A.3), comprising six custom Likert items. Weekly measures included the Weekly Usage Baseline (WUB – in the baseline condition – Section A.4) and the Weekly Usage Conditions (WUC – in the situated artifact conditions – Section A.5) with seven custom Likert items. Participants also completed the International Physical Activity Questionnaire (IPAQ – weekly before and during baseline, as well as situated artifact conditions) [15], containing the Metabolic Equivalent of Task (MET) minutes as resulting sum of intensity-weighted activity minutes. Further, participants answered the User Experience Questionnaire (UEQ – weekly during situated artifact conditions) [33]. Additionally, they filled out the Eudaimonic Technology Experience Scale (ETES – weekly during situated artifact conditions) [64] and the Technology-Supported Reflection Inventory (TSRI – weekly during
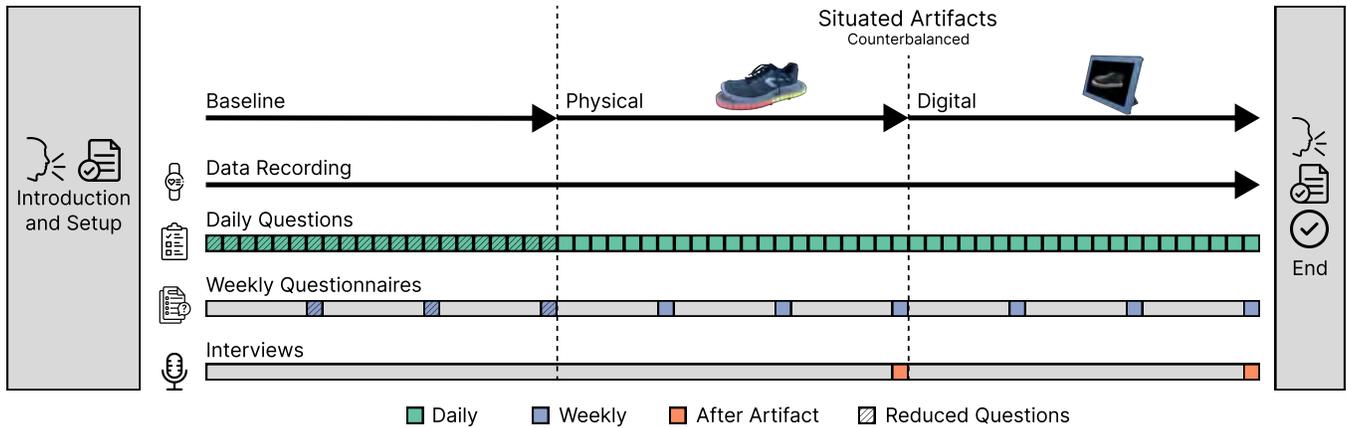
Figure 3: Procedure and timing of assessments during our 9-week field study. The daily and weekly questions during the baseline condition are reduced/fitted to not having an artifact in comparison to the daily and weekly questions during the physical and digital artifact condition (see Appendix A). This figure was created using resources from Flaticon.

situated artifact conditions) [5]. We provided all questionnaires using LimeSurvey. Lastly, we conducted in-depth semi-structured interviews after each condition (SSI – after situated artifact conditions – Section A.6).

4.4 Procedure

The overall procedure is depicted in Figure 3. At the study's start, each participant was invited to the lab, introduced to the procedure, and informed of their right to withdraw. Participants provided consent, with specific emphasis on using Google Fit for data logging and a chosen messenger for questionnaire reminders. For those without a fitness tracker, we provided a Samsung Galaxy Fit 2 and installed necessary applications, explaining usage and charging. Participants already using a tracker were asked to link their data to Google Fit and set a daily Heart Points goal. If no goal was set, we established one per WHO guidelines: 150 points per week (20 per day). We also installed the study app to collect Google Fit data and send it to our Firebase cloud, accessed by the situated artifacts to display activity. Once all applications were confirmed to work, participants began the study.

The first three weeks we collected baseline data on users' activity and motivation, minimizing the novelty effect of study participation (e.g., increased activity at the start). After three weeks, we provided the first situated artifact (physical or digital, counterbalanced). Participants chose where to place it, with the option to relocate as long as it remained visible daily. After three weeks, we exchanged the artifact and conducted a semi-structured interview. The artifact order was counterbalanced across singles and couples, ensuring each couple used the same prototype simultaneously. After three weeks, a final interview was conducted, apps were de-installed, data verified, and the artifact returned.

4.5 Ethics

For conducting the study, we followed the ethical guidelines of our institution and received approval from our ethics committee. We first explained the procedure to all participants and then obtained written and informed consent from them. All questions that were asked concerning the procedure were answered thoroughly before

the beginning of the study. All recorded interviews were manually transcribed, pseudonymized, and deleted after the end of the project.

5 Field Study Results

We structure the results by first reporting objective measures followed by subjective measures. The subjective measures are grouped by sampling frequency starting with daily followed by weekly and per-condition responses. Last, we report on the qualitative data. For each analysis, we first conducted Shapiro-Wilk tests to test if the data is normally distributed.

5.1 Objective Measures

In the following, we report on the Heart Points, Movement Minutes, and Distance Traveled. We normalized the data by subtracting the baseline's daily means from the daily values. Therefore, a value of 0 means participants were as active as during the first 3 weeks, a value > 0 means they were more active, and < 0 means less active. We performed paired t tests on the normalized data. In case of missing data, we exclude participants for the specific tests. The descriptive statistics are depicted in Figure 4. The t tests did not find statistically significant differences between the physical and digital situated artifact for Heart Point ($t(19) = 0.65, p = .52$), Movement Minutes ($t(19) = 0.75, p = .46$), and Distance Traveled ($t(22) = 1.50, p = .15$).

5.2 Subjective Measures

We first report the results of the daily questionnaires, including participants' self-estimation of their physical activity (DMB1 and DMC2), motivation from the situated artifact (DMB2 and DMC2), and motivation from other sources (DMB3 and DMC3). The data was normalized by subtracting the baseline's daily means from the daily values. During the baseline, participants were asked about motivation from the fitness tracker. Figure 5a depicts the results. Figure 5b charts the motivation elicited by the artifacts over three weeks, normalized against the baseline, demonstrating that the physical artifact outperformed the digital one on 18 of 21 days. We conducted paired t-tests to compare the two artifacts. We could not find a statistically significant change in the feeling of being
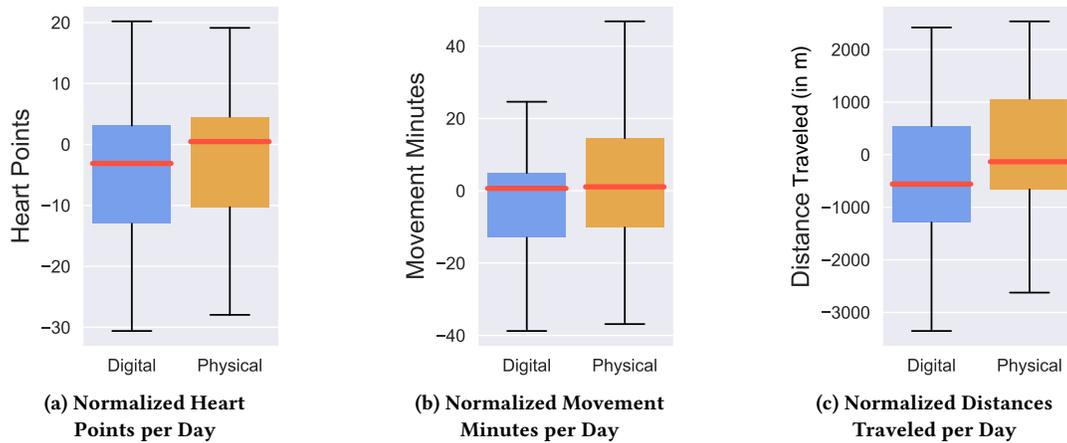
Figure 4: Boxplots illustrating the normalized objective measures of (a) Heart Points, (b) Movement Minutes, and (c) Distance Traveled for both the digital and physical conditions. Data normalization was performed by subtracting the daily means of the baseline from the daily values. Thus, a value of 0 indicates that participants' activity levels were equivalent to those of the first 3 weeks, a value > 0 signifies increased activity, and < 0 denotes decreased activity.

active on the given day ($t(23) = 1.38, p = .18$). However, motivation ratings were significantly higher for the physical artifact compared to the digital one ($t(23) = 2.28, p = .03$). No significant difference was found for motivation from other factors ($t(23) = 1.34, p = .19$).

For the weekly measures, we examined if participants used fitness trackers differently when using the situated artifacts (WUB1 and WUC3). With the Shapiro-Wilk test of normality failing, we conducted a Friedman test comparing the two artifacts and the baseline. The results showed a significant effect of conditions on engagement with fitness trackers and apps ($\chi^2(2) = 15.54, p < .001$). Post-hoc Wilcoxon tests with Bonferroni correction indicated significant differences between baseline and digital ($Z = 2.67, p = .0038, r = 0.39$) and between baseline and physical ($Z = 2.34, p = .0049, r = 0.34$). We also investigated if fitness trackers differently reminded participants to be active when using the artifacts (WUB2 and WUC4). Since the Shapiro-Wilk test failed, a Friedman test was conducted, but no significant effect was found ($\chi^2(24) = 3.16, p = .21$). Results are shown in Figure 6a. Participants reported how often they looked at the artifacts (WUC1), how much they were reminded to be physically active (WUC2), and how much they were influenced by others (e.g., partner, family, friends) (WUC5). Data were normalized by subtracting the baseline's weekly means from the weekly values. During the baseline, participants were asked about motivation from the fitness tracker (WUB1 and WUB2). Results are shown in Figure 6b. Paired t-tests indicated that participants looked at the physical artifact significantly more often than the digital one ($t(23) = 2.11, p = .046$), but no significant difference was found for reminders to be active ($t(23) = 0.76, p = .46$). Due to the failed Shapiro-Wilk test, a Wilcoxon Signed-rank test showed participants were significantly more influenced by others for the physical artifact than the digital one ($Z = -0.88, p = .039, r = 0.13$).

Next, we evaluated the influence of the artifacts on the ETES, TSRI, and UEQ scores. We could not find significant effects for any of the scores. The means and standard deviations are shown

in Table 1 in the appendix. Lastly, we measured participants' self-reported IPAQ scores. While we did not find significant differences, the calculated MET minutes during the baseline trended to be higher than during the conditions. The means and standard deviations for each score are presented in Table 2 in the appendix. At the end of the study, we examined which of the two situated artifacts participants preferred for everyday use. Figure 7 shows the participants' ratings. Due to failed Shapiro-Wilk test, we conducted a Wilcoxon Signed-rank test but did not find a significant effect ($Z = -1.67, p = .067$).

5.3 Qualitative Feedback: Interviews

We conducted two interviews per participant (one after finishing each 3-week phase using a situated artifact – see Figure 3), resulting in a total of 48 interviews with a mean duration of M = 19.96 mins, SD = 6.10 mins. The interviews were audio recorded and transcribed verbatim. Then, we applied Reflexive Thematic Analysis following Braun and Clarke [9, 10], which allows for inductive code and theme generation. Two authors utilized open coding using MaxQDA[9]. Next, the generated codes were iteratively refined with the inclusion of a third author. This process resulted in four overarching themes, each comprising three to four sub-themes. While themes capture higher-level patterns that directly address our research questions, sub-themes represent more specific dimensions or variations within these broader patterns, offering nuanced insight into participants' experiences with the prototypes in their everyday physical activity and social interactions. Below, we present these themes, illustrated with excerpts from the interviews. Interview fragments in languages other than English were translated by the authors. Each quote is accompanied by a participant ID and the condition during which the interview was conducted – do note that the participants may be referring to prototype versions that they were not using at the time of the interview when comparing to the prototype they used earlier.

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[9]MaxQDA, https://www.maxqda.com, last visited on 2026–03–08.

(a) Participants' Motivation for Physical Activity

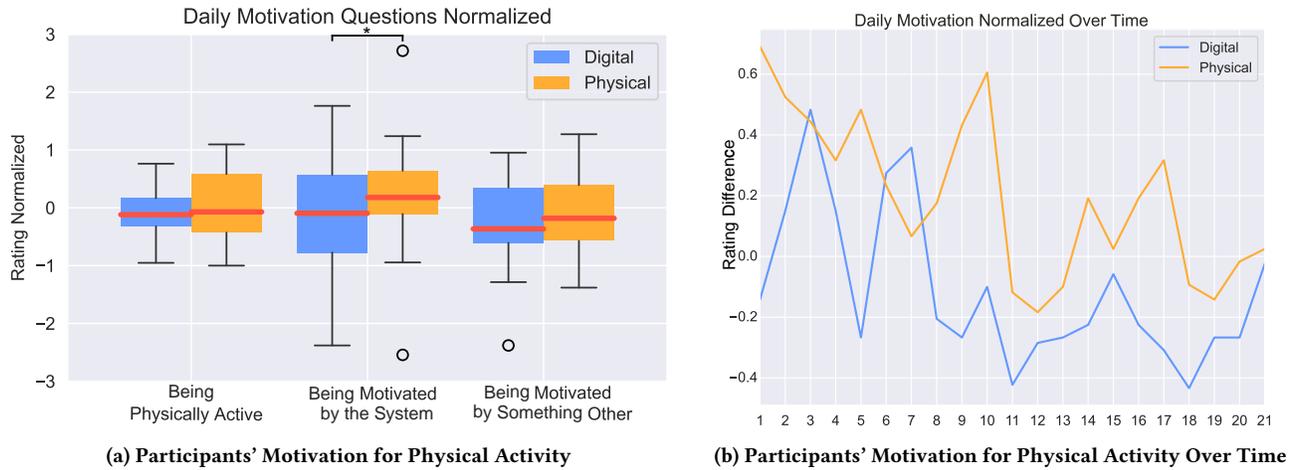(b) Participants' Motivation for Physical Activity Over Time

Figure 5: Participants' Daily Motivation for Physical Engagement Influenced by Situated Artifacts: (a) Boxplots displaying the mean motivation per participant per condition and (b) line graphs depicting motivation trends over time for both conditions.

(a) Weekly Questions Regarding the Tracker's Use

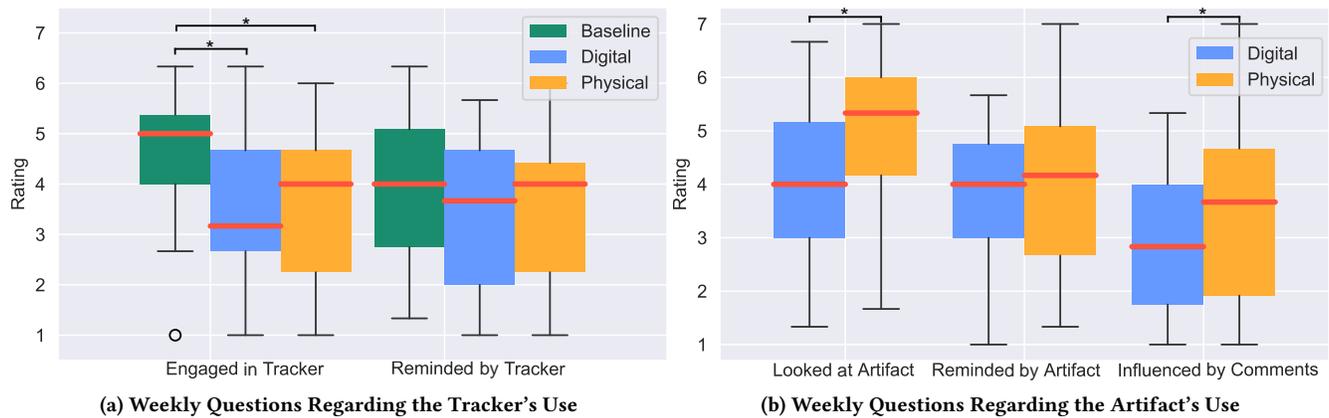(b) Weekly Questions Regarding the Artifact's Use

Figure 6: Boxplots illustrating participants' responses to weekly queries concerning (a) Fitness Tracker Usage: Emphasizing its role in engaging and reminding participants to stay physically active; and (b) Artifact Usage: Highlighting both the frequency of participants' interactions with artifacts and their efficacy in prompting and encouraging increased physical activity.
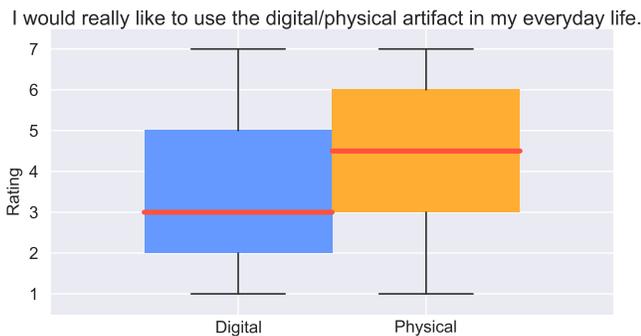

Figure 7: Boxplots displaying participants' ratings on the integration of the Situated Artifacts into their daily life.

5.3.1 Theme 1: Users Preferences–Physical over Digital over Trackers.
The first theme describes participants' use of the system, their placement of the artifact, and their preferences for physical and digital artifacts as well as fitness trackers.

Preferences in Everyday Usage: Initially, participants spent time getting accustomed to the fitness tracker and artifacts but soon integrated them into their daily routines. Regarding users' preferences, the physical artifact, noted for its ease of use, was checked at least once daily, often passively, as part of participants' natural environment. Many valued its simplicity and direct feedback, which contrasted with fitness apps typically opened only for detailed workout data. One participant noted, "It is better than via an app that is most of the time closed and then has to be actively opened on the phone" (P19, Physical). Another highlighted the physical artifact's straightforwardness: "The shoe was totally uncomplicated and straightforward as you know your activity level within half a second by looking at it" (P24, Digital). Artifacts were strategically placed in frequently accessed home areas, such as desks, kitchens, or hallways. "Since I'm usually in the kitchen at least once in the morning, noon, and evening, I placed it there" (P15, Physical). Participants aimed for a balance between visibility and non-intrusiveness.

Smartphone/-watch/Fitness Tracker Usage and Preferences: Participants often initially preferred integrated apps on smartphones and smartwatches to track simple metrics, like steps, and accessed more detailed data on their smartphones when needed. While some found smartwatch information sufficient and helpful as reminders, app usage generally declined over time except for apps that are used during specific training sessions or for training analysis shortly after finishing. Many participants were annoyed by persistent notifications of fitness apps, which are usually meant to motivate activity e.g. after prolonged sitting. This lead to disengagement with apps, while a few participants did not use the apps at all: "I just installed the apps for the setup and then never used them" (P24, Physical). This annoyance was echoed by others, who felt such notifications harmed their digital well-being. As a result, many preferred physical artifacts, finding them more effective as reminders. Unlike apps, the physical artifacts offered a constant, visible cue without intrusive digital alerts: "I think that with the existing apps you carry all information in your pocket all the time, which is actually more convenient. But it's not so much of a reminder in your pocket" (P7, Digital).

Artifact Preferences: While most participants favored the physical artifact, a minority preferred the digital one, citing its ability to display a wider range of data and visualizations that could be customized to personal preferences. They valued its less intrusive nature, especially in social settings where physical artifacts might draw comments from visitors. A few suggested integrating the digital artifact into existing devices like smartphones or desktop widgets to avoid adding another screen. However, many participants felt fatigued by constant screen exposure, as one noted: "I sit in front of a screen so much that it's just nice to have something that isn't a screen, so it's just the same information wrapped up in a different package" (P18, Physical).

On the contrary, most participants preferring the physical artifact, cited its greater visibility and meaningful presence compared to the digital version. One participant illustrated it with an analogy: "It is like an aquarium with a tropical fish: instead of a real clownfish swimming around and looking at you when you feed it, you can have your digital picture frame with a 24/7 YouTube stream of a clownfish. But then there is no connection, no feelings attached to it" (P13, Physical). Participants appreciated giving everyday objects a passive purpose, making them part of the decor. The physical artifact's design was praised for being more interesting, decorative, and eye-catching than the digital version: "The shoe as [physical] artifact is simply cooler than the tablet because it creates more physical presence" (P13, Physical). Participants also suggested improvements, like "more measured values" (P12, Physical) and "a smaller shoe that I can take with me as a key ring" (P15, Digital).

Overall, while smartphone apps, fitness trackers, and the digital artifact offer flexibility and data richness, the physical artifact excels in user engagement and simplicity, often becoming a meaningful part of the user's living environment. Participants expressed a clear preference for the physical artifact, suggesting it provides a more impactful and less intrusive method of promoting physical activity.

5.3.2 Theme 2: Awareness, Motivation, Reflection, and Change of Habits. The second theme describes the progression from initial reminders by the artifact to greater awareness, potentially motivating more physical activity. Over time, the artifact prompts reflection, accompanied by feelings of accomplishment or guilt, leading to minor habits adjustments, with the potential for behavior change.

Reminder and Awareness: Each morning, the artifact acts as a gentle reminder of participants' activity levels, fitness goals, and daily ambitions. This passive nudge is particularly effective during sedentary periods, such as home office work, fostering constant, low-level awareness without being intrusive. One participant noted, "It [the physical artifact] simply has a passive and indirect effect which I find much more pleasant, much more enjoyable" (P12, Physical). This feedback method promotes self-awareness by blending into daily routines, making participants mindful of their activity without requiring active engagement or disruption.

Nudge Leading to Motivation: The artifact serves as both a reminder and a motivational nudge, encouraging participants to use fitness apps and set tangible goals. The gamification aspect boosts motivation, turning goals into engaging challenges. One participant noted, "Transforming the concrete goal into something playful. For me, it makes a difference whether you still need 5000 steps or have the goal, the shoe has to be green - something abstract" (P18, Physical). This playful abstraction makes fitness pursuits more enjoyable and less daunting. While some participants relied primarily on intrinsic motivation, the artifact provided an extra incentive, acting as a visual encouragement to be more active and reinforcing their intrinsic desires.

Reflection and (Possibly) Sense of Accomplishment: Reflection often occurs in the evenings, evoking feelings from disappointment to pride and accomplishment. The latter contributes to a rewarding effect, reinforcing positive behavior. One participant stated: "The problem with unhealthy behavior is that you only see the effects after some time. Same for sports: You don't get any feedback, you don't get any positive feelings, but on the contrary, you have the feeling that you're not making any progress because the positive effects are only visible in the long term" (P24, Digital). The sense of accomplishment was reported to be more intense with the physical artifact, which provided clearer and more immediate feedback, helping participants become aware of their fitness levels.

Change of Habits: The artifact increased awareness and reflection, leading some participants to develop healthier habits. These new routines included activities like "Doing Hula Hoop with weights in front of the TV in the evening" (P20, Physical), taking regular activity breaks during home office hours, and finding motivation for walks in the afternoon or evening. The artifact's impact was strong enough that several participants wanted to keep it for long-term use to monitor their progress. The artifact not only supported the initial motivation but also inspired participants to maintain these new habits over the long term, possibly leading to behavior change.

The artifacts successfully initiated a cycle of awareness, motivation, and reflection, possibly leading to small habit changes. This process started with subtle reminders, enhanced motivation through playful gamification, and facilitated introspective reflection, sometimes leading to habit changes driven by renewed self-reflection and tangible feedback.

5.3.3 Theme 3: Evoking Social Interaction. The third theme explores how social interaction is evoked through comparisons with partners or others online. Participants also discussed interactions with visitors, friends, family, and colleagues who commented on the artifacts. This theme further includes privacy considerations arising from these social aspects.

Social Comparison: Both the physical and digital versions proved socially relevant, fostering competition, sparking conversations, and enabling social comparison. The artifacts encouraged competitive dynamics, particularly among couples. One participant noted: "Yes, with my partner it definitely motivated me. Why? Because I frequently wanted to be active. It was always my ambition to be at least as active as he was whenever I could manage it around work" (P20, Digital). The physical artifact prompted more discussions than the digital one: "We (my partner and me) had more discussions about the physical shoe than about the digital artifact" (P6, Digital). This competition boosted individual motivation and encouraged joint activities like evening walks. Non-coupled participants expressed a desire for social features, often via fitness apps, highlighting the value of social support and encouragement.

Interacting with Third Parties: The visibility of the artifacts often sparked spontaneous conversations about fitness when noticed by visitors or colleagues. Participants frequently explained the purpose and function of the artifacts to friends, family, and visitors, leading to engaging discussions. Regarding the physical artifact, a participant described: "Then of course the question came up what kind of unusual glowing object was standing around in my kitchen and I explained it. My friend was very enthusiastic about it." (P12, Physical). However, some noted potential drawbacks, such as annoyance to non-participating cohabitants. These conversations also served as reminders of activity levels, creating social pressure as participants shared their progress or lack thereof with visitors.

Privacy in Social Settings: Privacy concerns emerged due to the transfer of data from trackers and smartphones to the artifacts. Although data sharing was confined to cohabitants and visitors, and not public, participants still faced a trade-off between maintaining privacy and the motivational benefits of data visibility. Participants discussed that this needs careful consideration of the implications of visible activity levels within personal spaces.

Artifacts stimulated social interactions and discussions, which both positively influenced motivation and activity levels, but also raised privacy considerations due to visible data sharing. Notably, the physical artifact tended to evoke stronger social interactions compared to the digital version.

5.3.4 Theme 4: External Influences on Physical Activity. This theme examines external factors influencing physical activity, categorizing them into three areas: positive influences that promote activity, negative influences that impede it, and factors with mixed effects depending on the context.

Positive Influences: Participants often reported increased physical activity during less stressful periods when they felt relaxed and focused, such as after vacations, even though these were excluded from data collection. One participant noted: "I was on vacation where I basically did sports all the time [excluded from the study]. Maybe that could have influenced that I needed a little more exercise afterwards." (P22, Physical). Active weekend trips were also highlighted as positive influences, encouraging greater engagement in physical activities.

Negative Influences: Several factors negatively affected participants' physical activity, including work-related stress (e.g., deadlines and exams), private life stressors, and personal health issues like the flu. Additionally, activity trackers sometimes failed to accurately record activities, particularly stationary exercises like weight lifting. This lack of recognition could demotivate participants when their efforts were not properly reflected in the data.

Mixed Influences: The impact of certain factors on physical activity varied by context. Weather played a key role; good weather encouraged activities like hiking and biking, while bad weather kept participants indoors. The academic calendar also influenced activity, with more exercise during semesters through sports courses and a decline when courses were not in session. The shift to home office had mixed effects: some found it easier to take breaks and walk, while others missed the exercise from commuting and were less active. Overall, intrinsic motivation was crucial, as one participant noted: "For these artifacts to be effective, you have to be intrinsically motivated." (P20, Physical).

External factors such as stress, health, home office, weekend trips, and weather significantly influenced physical activity, either enhancing or inhibiting it depending on the context. Lastly, the role of intrinsic motivation was stressed by the participants.

6 Discussion

In this section, we discuss our research question by addressing subquestion RQ_1 to subquestion RQ_4, each within its own subsection. We integrate the findings from the quantitative data – both objective and subjective measures – with qualitative insights from participant interviews, situating our findings within existing research.

6.1 Presence, Reminders, Social Influences, and Developing New Habits

Addressing subquestion RQ_1 regarding the presence of reminders and social influence (WUB and WUC), we observed intriguing dynamics in participants' engagement with trackers, apps, and the situated artifacts. Initially, participants displayed high levels of engagement with the trackers and apps. However, once they placed the artifacts in their homes, their engagement in the tracker and apps significantly declined. This decline occurred more rapidly than typically expected without an artifact, where such a reduction in usage would generally only emerge after approximately 100 days [22]. Therefore, in our 63-day study, the presence of the artifacts likely caused this decline by providing participants with a comprehensive overview of their data, eliminating the need to delve into use fitness tracker or apps to gain an overview. The prominence of trackers and apps diminished, with the artifacts becoming the primary reference for a quick overview of physical activity data, while fitness apps are utilized during the training or for in-depth exploration of specific training session.

The physical artifact's tangible uniqueness made it stand out more in participants' environments than the digital version. Our findings show that participants were more frequently drawn to the

physical artifact, with significantly higher engagement levels compared to the digital one. This can be attributed to the connection of a narrative to the artifact [43]–being a sports shoe usually worn for exercising–and the tangibility [18, 30]. Moreover, this design attribute of the physical artifact encouraged discussions among participants and their social circles. Many participants felt prompted by comments from partners, family, and friends to engage in more physical activities when interacting with the physical artifact. This aspect was also observed by Botros et al., where participants experienced emotions such as pride and guilt – likely intensified by the fact that their artifact was a living plant that received water in proportion to the participants' physical activity [8].

Interestingly, couples who participated in our study reported a heightened level of interaction surrounding the physical artifact. Conversations often revolved around playful teasing, a sense of competition, and collective physical activity planning, falling into the categories of comparison and conversation as design resources for reflection, as identified by Bentvelzen et al. [7]. A recurrent topic in our interviews was the emergence of a new shared routine among couples – taking walks together in the afternoons if the artifacts visual feedback indicated they had not met their activity goals. Another notable behavior change was observed during evenings when participants, upon seeing the shoe still indicating low activity, would engage in short exercise sessions while watching television.

In essence, the introduction of the physical artifact not only shifted the locus of attention from trackers and apps to the artifact but also fostered a social interaction resulting in motivation to be physically active. This phenomenon was stronger for the physical artifact than the digital counterpart.

6.2 Consciousness and Reflection of Activity Goals

In addressing subquestion RQ_2, we compared our measured values against existing benchmarks. Although established benchmarks for ETES [64] and TSRI [5] are still developing, meaningful comparisons can be made with systems designed to promote healthier lifestyles. For instance, Loerakker et al. reported mean Overall TSRI Scores between 22 and 32 for a system visualizing screen time [37], while Aragon-Hahner et al. found mean Overall TSRI Scores of 39 for a self-reflection app supporting career choices [3]. In the domain of fitness, Strömel et al. reported mean Overall TSRI Scores between 26 and 29 across different conditions, with subscores of 7.6 to 8 (Insight), 11 to 12 (Exploration), and 7.5 to 9 (Comparison), based on an online survey about step data [53]. In comparison, our prototypes demonstrated higher average scores but also showed a greater standard deviation, indicating more variability in user responses. This suggests that while our system may be more impactful for some users, there is also a wider range of user experiences.

Considering the UEQ results for the situated artifacts, we observed some divergence from the benchmarks at the time of conducting the study [33, 48]. The mean attractiveness using UEQ was 1.47, and the mean values for pragmatic and hedonic quality were 1.50 and 0.95, respectively. Particularly, the mean attractiveness score was noted to be lower than benchmark values [49]. However, a closer examination, considering the standard deviation, unveils a

pronounced divergence in user opinions. This suggests that the artifacts were perceived very favorably by certain participants while others found them less appealing in terms of their attractiveness, which was also supported during the interviews. The Pragmatic and Hedonic Quality metrics exhibited values proximate to the mean benchmarks, highlighting a relatively neutral reception by the participants. The high standard deviation for the Hedonic Quality in relation to its mean, again reinforces the polarized user reception, consistent with our earlier observation regarding attractiveness.

Regarding MET scores, which summarize minutes of vigorous, moderate, and walking activity weighted by their metabolic equivalents, as calculated by the IPAQ, a higher value was observed during the baseline assessment. Given the self-reflective nature of the artifact's design, it can be inferred that participants developed heightened awareness about their physical activities as the study progressed. Many participants recognized that their initial perceptions of their activity levels, particularly in sports, moderate activities, and walking, were overestimated when compared to the recorded and via the artifact displayed data.

Our interviews provided deeper insights into these findings. Participants often reported revisiting and reflecting upon their activity data, leading to the realization that achieving the daily WHO activity goals could be accomplished by mere routine activities like walking to work or commuting. However, the demands of daily life, further intensified by the increase in home office, often made them less active than the WHO-recommended levels.

The physical artifacts, especially their visual cues, proved instrumental in this context. By passively reminding participants, especially those in home office setups, of their activity (or lack thereof), the artifacts stressed the importance of short breaks with physical activity in the participants' minds. In conclusion, the situated artifacts played a crucial role in enhancing participants' self-awareness and adjusting their self-assessment metrics concerning their activity.

6.3 Physical Situated Artifact Motivates and Rewards

In addressing subquestion RQ_3 regarding motivation and activity, we observed that the descriptive statistics of continuous measures such as heart points, movement minutes, and distance traveled were slightly higher for the physical artifact compared to the digital artifact. However, it is important to note that these differences were not statistically significant. When we normalized heart points and movement minutes of the conditions against the baseline (see Figures 4a and 4b), we found that while they appeared closely related, there was a notable difference in the interquartile ranges. The IQR for normalized heart points of the physical artifact is larger than for the digital artifact, showing higher values, which is not present in the nomalized movement minutes. This finding indicates that the physical artifact may encourage more short walks and standing up during home office activities, which is evidenced by insights from participant interviews. Participants reported using the artifacts for self-reflection, particularly during home office hours. This observation aligns with the interviews, where participants mentioned engaging in short walks in the afternoon or incorporating mobility through walking or bicycling. This finding is consistent

with Kocielnik et al., who observed that their reflection companion similarly prompted the adoption of new behaviors [32].

Interestingly, we did find a significant result indicating that motivation through the physical artifact was higher than through the digital artifact (DMB and DMC). This suggests that the concept of motivating users through the physical artifact did have the expected effect. Still, participants have varied sources of motivation, with some being primarily driven by intrinsic factors, while others relied on social aspects, such as engaging in sports with friends or participating in regular sports courses. These motivational sources are often times perceived way stronger than the artifact, hiding its effect. Following Fogg's principles of competition, cooperation, and recognition, interactions with partners, co-inhabitants, or visitors could enhance intrinsic motivation [19].

Participants felt encouraged when the artifact signaled goal achievement. Interviews revealed that seeing the shoe light up green in the evening evoked a sense of reward and accomplishment. In the context of visualizing shoe-worn sensor data, Woźniak et al. also emphasized the value of immediate feedback after workouts [65]. The authors highlight that simple metrics can serve as effective tools for reflection, aligning with our findings. However, it is worth noting that we did not achieve significant results for increased overall activity levels, which can be attributed to the complexities of a field study and the multitude of factors affecting participants' daily lives at work and during leisure time (also see Section 6.5). Therefore, the changes reported in the interviews were too subtle to measure significantly in real-life settings, reflecting only minor modifications in daily habits. Interviews revealed that personal and work-related stress could significantly reduce participants' activity levels, obscuring minor habit changes. In these cases, the system sometimes even led to negative emotions in the evening, such as self-disappointment, which, according to Lin et al., needs to be avoided, especially when individuals are not meeting their own expectations, to foster long-term behavioral change [36]. Takahashi's study on manipulating step counts reveals that altering participants' perceived progress could influence their emotional response to goal achievement [56]. Although the effects were also not statistically significant, a trend toward increased self-efficacy was reported.

As expected, motivation levels decreased over time, as it is typical with novelty effects, especially in such a field study. However, it is noteworthy that motivation remained consistently higher in the physical artifact group throughout the 21-day study duration for each condition. These findings collectively suggest that while the physical situated artifact effectively motivates and rewards users, its advantage over the digital artifact and impact on overall activity are influenced by external factors and individual motivations.

6.4 Willingness to Engage in Everyday Usage

In addressing subquestion RQ_4, the preference for a particular artifact did not show a significant difference. This observation can be attributed to contrasting responses from a subset of participants that deviated from the majority. The descriptive data shows that a notable majority expressed a fondness for the physical prototype. Their preference was grounded on its non-screen-based nature, comparable to Sauvé et al.'s work [47], allowing for a passive reflection

of data. Additionally, its distinctive design engendered discussions with partners, co-inhabitants, or even occasional visitors. Participants even integrated it as design element in their homes, similar to the approach observed by Menheere et al. [40], often situating it in visible locations such as shoe cabinets or living rooms.

Conversely, a fraction of participants voiced concerns regarding data privacy. For them, even though the physical artifact was intriguing, they leaned towards using the digital display or choosing not to use any of the artifacts at all. Their rationale was rooted in the desire for discretion, especially in contexts where visitors were present. Some participants articulated their interest in a desktop or smartphone background widget, for example during home office.

Interestingly, this feedback aligns with the sentiments of those who expressed a desire for a mobile artifact. Such an artifact, they suggested, would fit inside a pocket and could offer detailed data visualizations, possibly expanding to metrics like calorie and water intake. However, upon reflection, they recognized that their description closely mirrored the functionality of their smartphones. An essential takeaway from this feedback was the distinction in participants' engagement patterns: while engaging in physical activities, they exhibited keen interest in data and statistics accessible on their smartphones. However, during everyday tasks, devices other than their usual screens (e.g. computers, smartphones) proved more impactful in prompting them to recall their physical activity goals. This finding is consistent with Thudt et al., who discovered that data collection, construction, and self-reflection are strongly interconnected. A screen primarily used for other tasks, such as work, may not be associated with physical activity, thereby reducing the presence of users' goals in everyday life [60].

To address the sustainability concerns of physical artifacts, it is essential to balance their motivational benefits against drawbacks like production costs and environmental impact. These artifacts can be costly and contribute to waste as users eventually move on from them. Moreover, questions arise around the energy efficiency of such systems–particularly whether digital artifacts need to remain permanently active or whether physical elements (e.g., LED strips) can be turned off to save energy. Thus, developing solutions that are both effective in promoting physical activity and compatible with future upgrades and sustainable practices is imperative.

6.5 Limitations

For both the design survey and the field study, we acknowledge that recruiting participants via university mailing lists and social media in Germany likely introduced a sampling bias toward individuals with higher levels of education and specific cultural or regional backgrounds. In addition, both studies were conducted with relatively small sample sizes (N_{DS} = 25 and N = 24), which may limit the generalizability of the findings and reduce the statistical power to detect significant effects. A confounding factor that emerged from the interviews was the role of weather on participants' motivation. The study period for participants ranged from 2023-05-30 to 2023-06-15. Consequently, their baseline weeks primarily covered the month of June and, in some cases, the early part of July. This period was meteorologically favorable, marked by minimal rainfall–with a single exception of a day characterized by heavy rain–and a generous amount of sunshine. However, as the study

progressed to its later stages, during which participants interacted with both the digital and physical artifacts, weather conditions showed a noticeable change. This phase, ranging between 2023-08-01 and 2023-09-05, witnessed more temperate climates coupled with increased rainfall. Another limitation worth noting is the potential increase in self-reflection among participants due to their consistent engagement with surveys over nine weeks. This continuous involvement might have unintentionally influenced their self-awareness and -reflection concerning physical activity.

6.6 Broader Impact on Society

This research addresses critical societal needs by enhancing physical activity awareness and engagement. The situated artifacts developed in this study not only served as reminders and motivators of daily physical activity but also acted as catalysts for social interaction and community building. By integrating these artifacts into everyday settings, our study highlights the potential for tangible, interactive technologies to foster a culture of health and well-being. The physical artifact, in particular, proved effective in not only encouraging individual reflection on activity levels but also in promoting social discourse around health, nudging habit changes that, while minor, cumulatively contribute to public health. By bringing to light the effectiveness of tangible artifacts in a digital age, this study suggests a reevaluation of how health-promoting technologies can be designed and integrated into our lives. This could lead to health interventions that are emotionally resonant and socially engaging, thus enhancing the well-being of the broader community.

7 Conclusion

Overall, we designed two *Situated Artifacts* – a digital and a physical variant – with the goal of motivating physical activity. We evaluated these artifacts over a span of nine weeks in a counterbalanced, within-subject field study with 24 participants. We collected continuous measures, daily and weekly questionnaires, and conducted interviews after each 3-week artifact usage period. The digital artifact proved its value as a constant reminder, continually nudging participants about their activity levels. However, the physical artifact surpassed its digital counterpart in terms of presence, motivational potential, and social influence. Its presence not only encouraged users to reflect on their activity levels but also evoked more associations to converse about, fostering social interaction. These interactions often lead to minimal changes in their participants' routines, such as going for a walk in the afternoon or a spontaneous hoola-hoop session in front of the television. However, participants showed mixed preferences. While some favored more portable, feature-packed versions, their descriptions unintentionally mirrored the characteristics of common fitness apps. This observation highlights a notable contradiction – the very tools designed to support our health often go unnoticed among a flood of notifications and everyday life stress. In conclusion, while the appeal of digital tools with extensive features is clear, our study highlights the often-overlooked value and effectiveness of tangible, physical objects. They not only connect on an emotional level but also encourage social interaction and discussion, advancing the primary goal of promoting physical activity in subtle yet meaningful ways.

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A Questionnaires and Interviews

A.1 Consent Form (CF) including Demographics

CF1 ID-Code (Pseudonymization)

CF2 First- and Lastname (Consent)

CF3 Gender, Sex, Age, Height, Weight (Calculating Health Metrics)

CF4 E-Mail Address (optional to receive results)

CF5 Consent to publish photos of the shoe placement (optional)

Individual 7-point Likert Items:

On a scale from 1 to 7 with 1 meaning "strongly disagree", 2 meaning "disagree", 3 meaning "somewhat disagree", 4 meaning "neutral", 5 meaning "somewhat agree", 6 meaning "agree", and 7 meaning "strongly agree", how do you rate the following statements:

A.2 Daily Motivation Baseline (DMB)

DMB1 I was very physically active today.

DMB2 I was very motivated by the Fitness Tracker and Apps to be physically active today.

DMB3 I was very motivated by something other than the Fitness Tracker and Apps to be physically active today.

A.3 Daily Motivation Conditions (DMC)

DMC1 I was very physically active today.

DMC2 I was very motivated by the shoe to be physically active today.

DMC3 I was very motivated by something other than the shoe to be physically active today.

A.4 Weekly Usage Baseline (WUB)

WUB1 I looked at the Fitness Tracker and Apps very frequently this week.

WUB2 The Fitness Tracker and Apps strongly reminded me to be physically active this week.

A.5 Weekly Usage Conditions (WUC)

WUC1 I looked at the shoe very frequently this week.

WUC2 The shoe strongly reminded me to be physically active this week.

WUC3 I looked at the Fitness Tracker and Apps very frequently this week.

WUC4 The Fitness Tracker and Apps strongly reminded me to be physically active this week.

WUC5 Other persons' comments on the shoe influenced my motivation to be physically active this week.

A.6 Semi-structured Interview (SSI) (after situated artifact conditions)

Usage of the shoe:

SSI1 Tell me the story of how you used the shoe and/or whole system (smartphone, Fitness Tracker and Apps, shoe).

SSI2 Where did you place the shoe in your home? (optional: take a photo)

SSI3 Why did you place it there?

SSI4 Did you change the place during the study or between conditions?

SSI5 What was happening in your life at the time you were using the system?

SSI6 Are you working from home or rarely do home office? How many home office days did you do per week on average within the study period?

SSI7 Did you look at the system? At what time of day? How often? What part of the whole system?

SSI8 Describe your use of the system.

SSI9 How did you feel before/during/after using the system?

SSI10 What did you think when using the system?

Social Aspects:

SSI11 How many coinhabitants do you have?

SSI12 Did you talk about the shoe with flatmates/friends/other people? (Why (not)? What did they/you talk about?)

SSI13 Did any of your visitors notice the shoe or comment on it? (What did they say? In a positive/negative way?)

SSI14 Did these conversations influence your motivation to be physically active? And if yes, how?

SSI15 Have you been using social features in fitness apps (e.g. sharing activity and workouts or some form of gamification)? If yes, how does it compare to your experience with people seeing and eventually commenting on the shoe?

Behavioral Change Aspects:

SSI16 What, in your opinion, is the purpose of the shoe?

SSI17 Did the shoe change your sense of accomplishment? (Positive / Negative?)

SSI18 Did the shoe change how you feel about your fitness?

SSI19 Is there a role for such systems in supporting people's well-being?

Human-centered design:

SSI20 Did you miss anything when using the system?

SSI21 What would you change about the system?

SSI22 Would you continue using the system? (Why? Why not? Which part?)

SSI23 If Apple, Google, or other well-known brands sold such a system, would you buy it?

SSI24 (Only during closing interview:) On a scale from 1 to 7 with 1 meaning "strongly disagree", 2 meaning "disagree", 3 meaning "somewhat disagree", 4 meaning "neutral", 5 meaning "somewhat agree", 6 meaning "agree", 7 meaning "strongly agree", how do you rate the following statements: (a) "I would really like to use the digital artifact in my everyday life!", (b) "I would really like to use the physical artifact in my everyday life!"

SSI25 (Only during closing interview:) Which shoe did you prefer? Why?

SSI26 Is there any additional feedback?

Table 1: Summary of Scores for ETES, TSRI, and UEQ

Metric	Digital Mean	SD	Physical Mean	SD
ETES				
Eudaimonic goals	7.33	2.88	7.28	3.13
Self-knowledge	6.06	2.78	5.82	3.07
ETES	13.39	5.40	13.10	5.97
TSRI				
Insight	9.27	3.50	9.33	4.03
Exploration	13.31	3.72	12.58	3.62
Comparison	11.48	4.69	11.53	4.93
Overall TSRI Score	34.06	9.33	33.44	10.73
UEQ Scores				
Attractiveness	1.05	1.09	0.85	1.06
Pragmatic Quality	1.51	0.68	1.40	0.68
Hedonic Quality	0.81	0.91	0.90	0.70

Table 2: Summary of IPAQ Scores across Baseline, Digital, and Physical

Metric	Baseline Mean	SD	Digital Mean	SD	Physical Mean	SD
Vigorous minutes	133	144	87	91	101	150
Moderate minutes	115	156	65	114	63	81
Walking minutes	246	380	189	263	180	163
Sitting minutes	568	243	558	176	562	164
Total MET minutes	2335	1880	1578	1230	1653	1252