

A Digital Serious Game for Promoting End-of-Life Discussions (Anticip'ation): Usability Study

Dafne Campioni, Frederic Ehrler, Antoine Berger, Christine Clavien

Submitted to: JMIR Aging
on: March 04, 2025

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A Digital Serious Game for Promoting End-of-Life Discussions (Anticip'action): Usability Study

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Abstract

Background: In the context of an aging population, it is crucial to promote early discussions to help patients express their view on what is essential in their life, on their preferences over future medical treatments and on end-of-life issues. An inter-professional research team at Geneva University and HUG hospital, has developed a digital version of Anticip'action, a game designed to initiate and conduct end-of-life planning discussions, that can be used on a smartphone or tablet.

Objective: This study aimed at assessing the ergonomic quality of the digital version of the game.

Methods: 10 representative users completed a usability test conducted online with a filmed video-conference system. The test began with a rapid desirability test to capture initial impressions on the main screen of the game without knowing what it is about. It was followed by a think-aloud procedure, including 26 tasks to perform all steps of the game. Finally, post-test questionnaires were conducted to collect participants' feedback on the usability (SUS), attractiveness (AttrakDiff), relevance and subjective endorsement of the game (Mobile App Rating Scale), as well as open questions to further explore usability issues. Usability problems were categorized and evaluated with the use of standard evaluation grids. Content readability was evaluated with Scolarius, a French equivalent of the Flesch Reading Ease test.

Results: The rapid desirability test revealed an overall good or average impression. The aesthetic of the game left participants mostly indifferent, and some misinterpretations could be noticed. In 83.2% of the cases (208/250), participants successfully completed the think aloud tasks without assistance. Some tasks revealed usability issues requiring assistance. The analysis of failures and difficulties encountered (23 in total) revealed that some issues were due to a suboptimal wording of task instructions, and that there are 9 major usability problems. All could be addressed with minor modifications. The Scolarius test indicates that the card titles are understandable for elementary school level users while the rectos containing more explanations require high school level. At the end of the test, Anticip'action was evaluated between good and excellent on its usability (79/100 on the SUS questionnaire) and obtained an overall positive assessment on its attractiveness (global score of 1,6 on AttrakDiff questionnaire) and relevance (4.1/5 on the Mobile App Rating Scale, section F). Participants provided overall positive qualitative feedback and endorsed the game (3.3/5 on the "I would recommend" question).

Conclusions: The usability of Anticip'action was evaluated as good by users and minor area of improvement were identified. Anticip'action, which is freely available, can be recommended as a valuable resource for patients, families, and caregivers to prompt reflection, raise awareness, and support advance care planning conversations. Clinical Trial: The study was preregistered on the OSF platform: <https://osf.io/8gzsf>.

(JMIR Preprints 04/03/2025:73378)

DOI: <https://doi.org/10.2196/preprints.73378>

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Abstract

Background: In the context of an aging population, it is crucial to promote early discussions to help patients express their view on what is essential in their life, on their preferences over future medical treatments and on end-of-life issues. An inter-professional research team at Geneva University and HUG hospital, has developed a digital version of *Anticip'action*, a game designed to initiate and conduct end-of-life planning discussions, that can be used on a smartphone or tablet.

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Results: The rapid desirability test revealed an overall good or average impression. The aesthetic of the game left participants mostly indifferent, and some misinterpretations could be noticed. In 83.2% of the cases (208/250), participants successfully completed the think aloud tasks without assistance. Some tasks revealed usability issues requiring assistance. The analysis of failures and difficulties encountered (23 in total) revealed that some issues were due to a suboptimal wording of task instructions, and that there are 9 major usability problems. All could be addressed with minor modifications. The Scolarius test indicates that the card titles are understandable for elementary school level users while the rectos containing more explanations require high school level. At the end of the test, *Anticip'action* was evaluated between good and excellent on its usability (79/100 on the SUS questionnaire) and obtained an overall positive assessment on its attractiveness (global score of 1,6 on AttrakDiff questionnaire) and relevance (4.1/5 on the Mobile App Rating Scale, section F). Participants provided overall positive qualitative feedback and endorsed the game (3.3/5 on the "I would recommend" question).

Conclusions: The usability of *Anticip'action* was evaluated as good by users and minor area of improvement were identified. *Anticip'action*, which is freely available, can be recommended as a valuable resource for patients, families, and caregivers to prompt reflection, raise awareness, and support advance care planning conversations.

Registration: The study was preregistered on the OSF platform: <https://osf.io/8gzsf>.

Keywords: advance care planning; mHealth; mobile apps; mobile health; mobile phone; palliative care; usability; serious game; conversation tool

Introduction

In the context of an aging population, it is crucial to promote early discussions to help patients

express their view on what is essential in their life, on their preferences over future medical treatments and on end-of-life issues overall^{1,2}. Discussions about values and priorities contribute to increase patient's empowerment and to decrease distress among surrogates and health professionals when important medical decisions have to be made³.

However, these anticipatory discussions are often delayed or avoided due to a multitude of barriers such as healthcare professionals' lack of trust in their communication abilities, time constraints, emotional burden, fear of generating misunderstandings or conflicts⁴⁻⁷. To overcome these obstacles, it is crucial to develop strategies and communication tools that facilitate the initiation and conduction of end-of-life discussions.

Studies indicate that free online digital tools (websites, applications, online games, etc.) could enhance interest, communication and decision-making related to advance care planning⁸⁻¹². These communication tools may serve as icebreaker, provide a securing frame for conducting a discussion, and save clinicians' time. Indeed, digital tools are easy to share with patients and can provide relevant information and input to conduct part of the reflexion in the private and familial context ahead of the medical consultation. However, with some exceptions¹³, existing solutions are mostly in English and not necessarily adapted to European cultural context.

An inter-professional research team at Geneva University and HUG hospital, composed of ethicists, physicians, nurses, trained patients as partners, information technology professionals, has developed information and communication tools to support the culture of advance care planning. In particular, the digital tool *Accordons-nous* ("Let's agree") is freely available as a module integrated to the larger *Concerto* application at the HUG¹⁴, which is downloadable on Play Store and App Store or can be accessed online. *Accordons-nous*¹⁵ includes information related to advance care planning, discussion prompts, an advance directive form, and a digital version of the card game *Anticip'action*.

Anticip'action is a card game designed to help users to clarify their values and priorities in life, to discuss about them with their loved ones and healthcare professionals, and to plan concrete actions regarding care and end-of-life decisions. It is inspired by the game *Go Wish*¹⁶ but contains its own set of cards adapted to the Swiss cultural context and additional rules and contents. It can be used with caregivers during structured advance care planning discussions, or it can be proposed as icebreaker to be played independently at home with closed ones. A printable version is available in different languages (English, French, German, Italian) and the digital version is available in French in *Accordons-nous* (see Textbox 1 & Figures 1-3). Here, the results of a usability test of the digital version of the game are presented.

Textbox 1. Short description of the game rules of *Anticip'action*

The game is divided into 3 phases: 1. In "Prioritize", the task is to rank 32 cards into four categories ("Very important", "Important", "Not important", "Unsure"). Examples of cards are "Looking after my appearance" or "Expressing what I couldn't stand." Each card has explanations on the back. 2. In the phase "Specify", the task is to add personal details on the cards that have been selected as very important and decide whether the topic is already resolved or still in need for some action. 3. In the phase "Act", the task is to write what actions could be done to address the important issues highlighted in the previous phase. To assist in this task, each card suggests possible actions (e.g. schedule an appointment with a healthcare provider, arrange a meeting with a loved one). The output of the game is a PDF summary of cards ranking, specifications provided during the game, and to-do-list of actions to be done.

Figure 1. Welcome page of *Anticip'action* included in the *Accordons-nous* module.

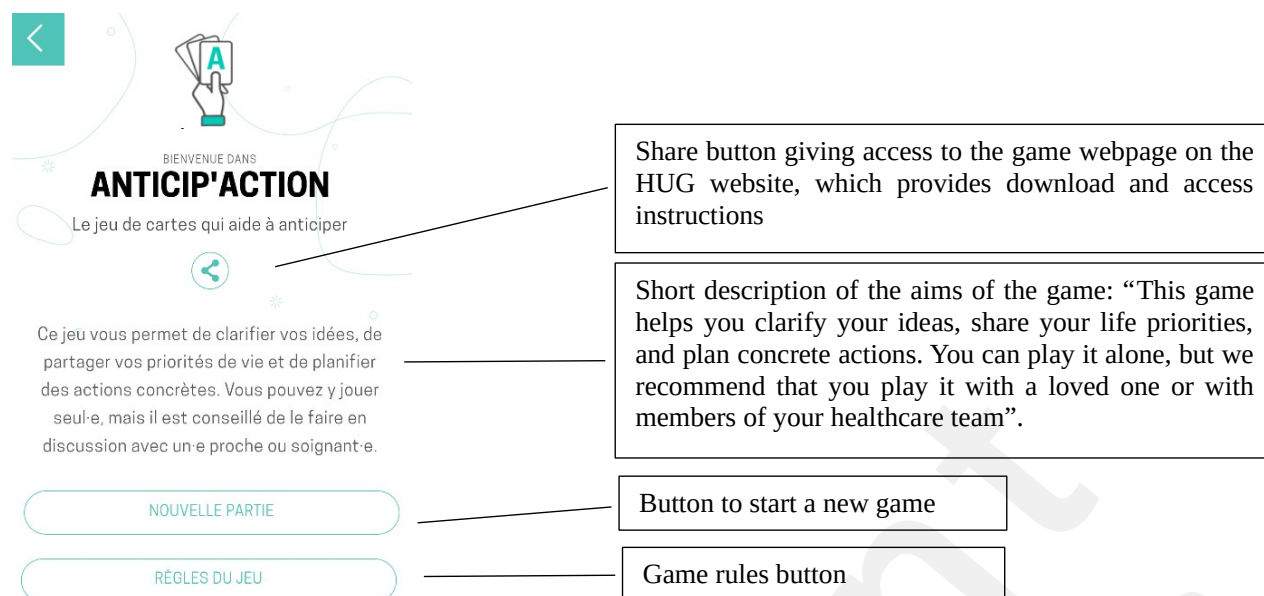


Figure 2. Main screen of the game.

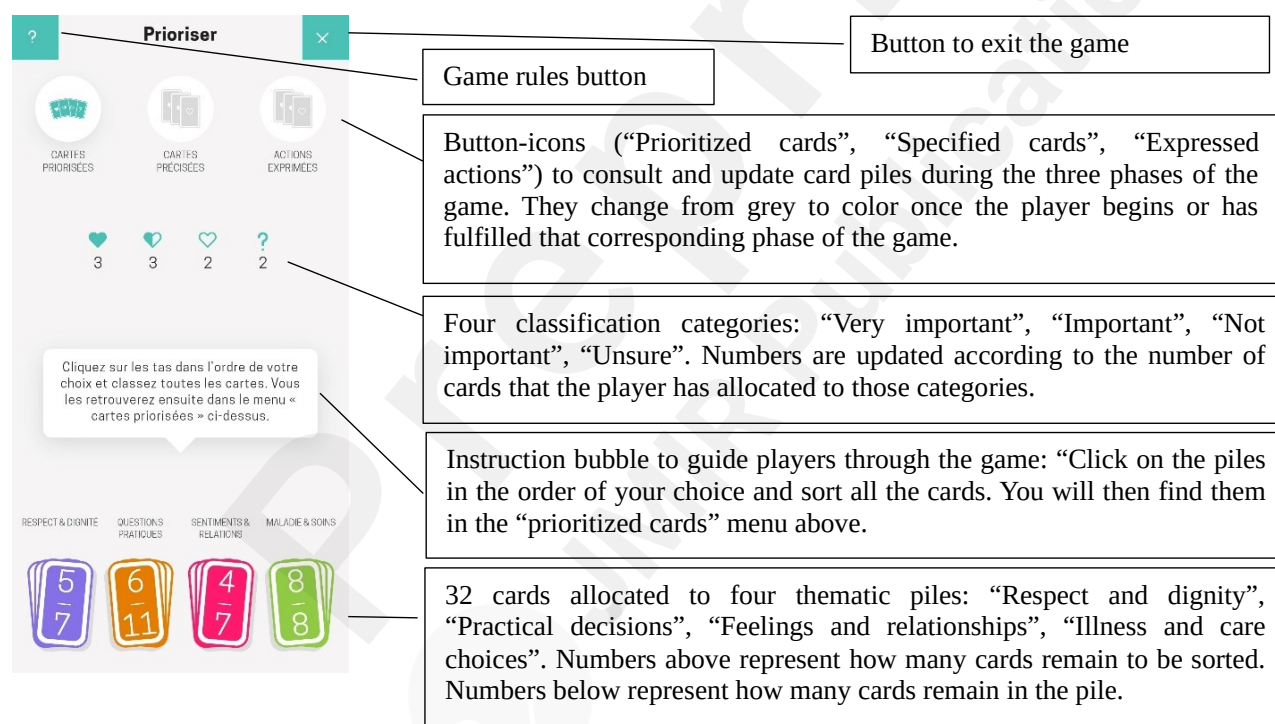


Figure 3. Phase 1 - Prioritize: screen allowing to sort cards allocated to the theme "Practical decisions."

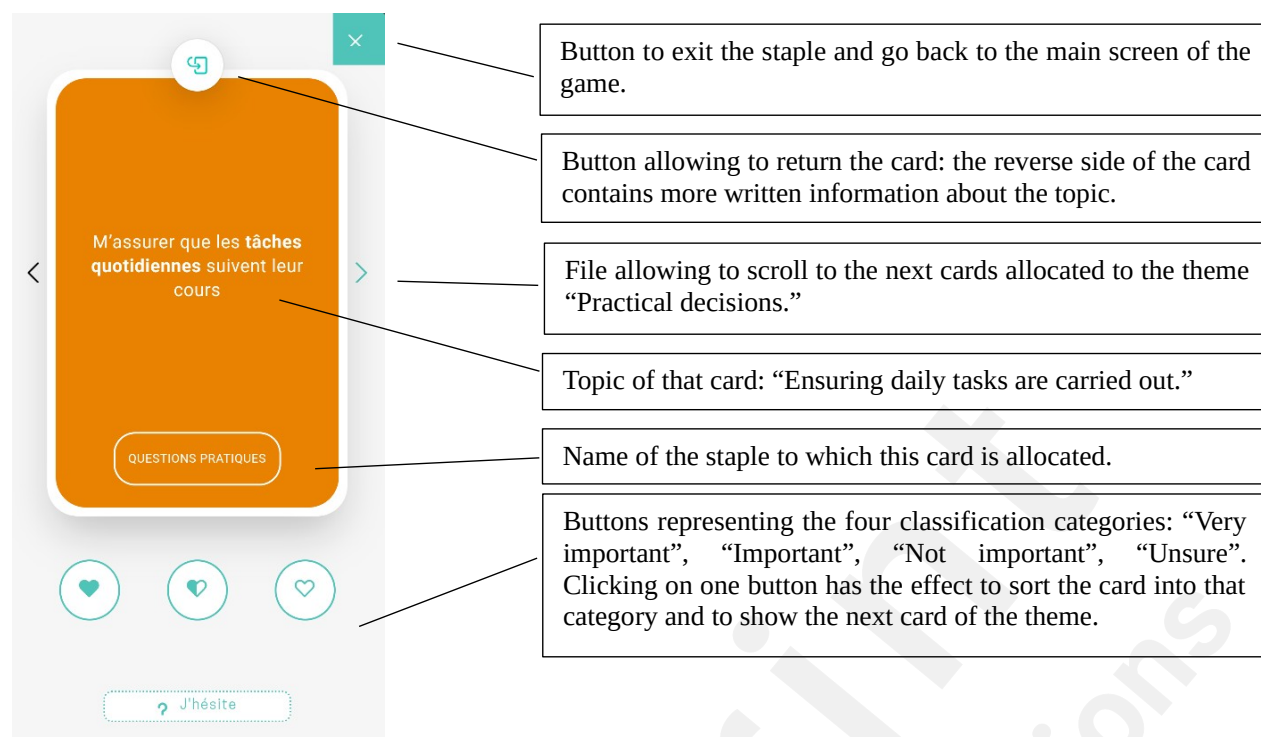


Figure 4. "Prioritized cards" screen allowing to resort cards in different categories at any time of the game. It can be accessed from the main screen, by clicking on the "Cards Prioritized" button-icons (top left).

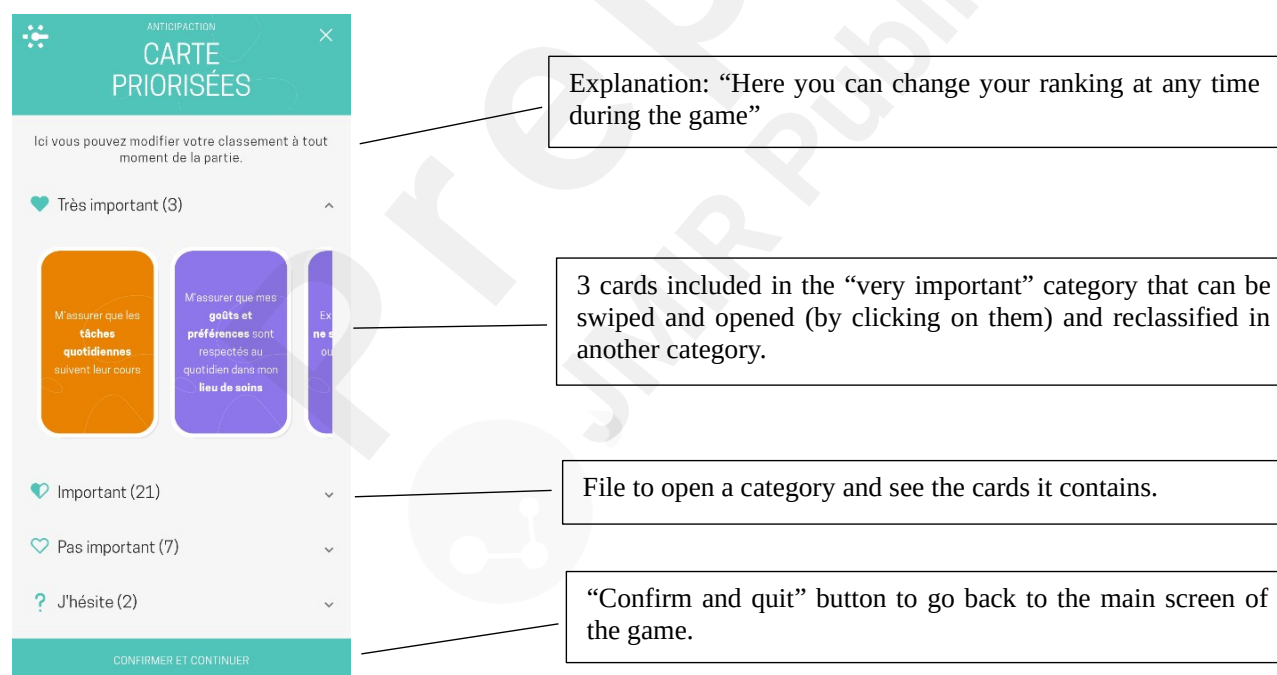


Figure 5. Phase 2 - Specify: screen allowing to specify reasons for having selected cards as "very important."

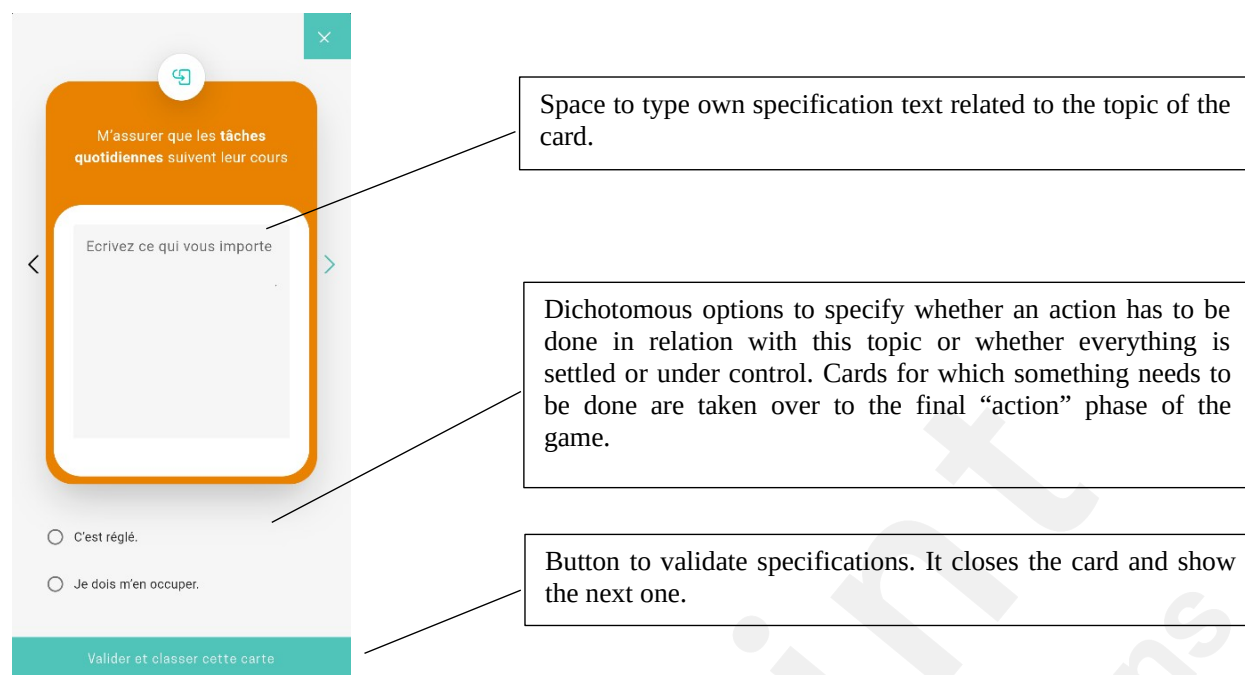
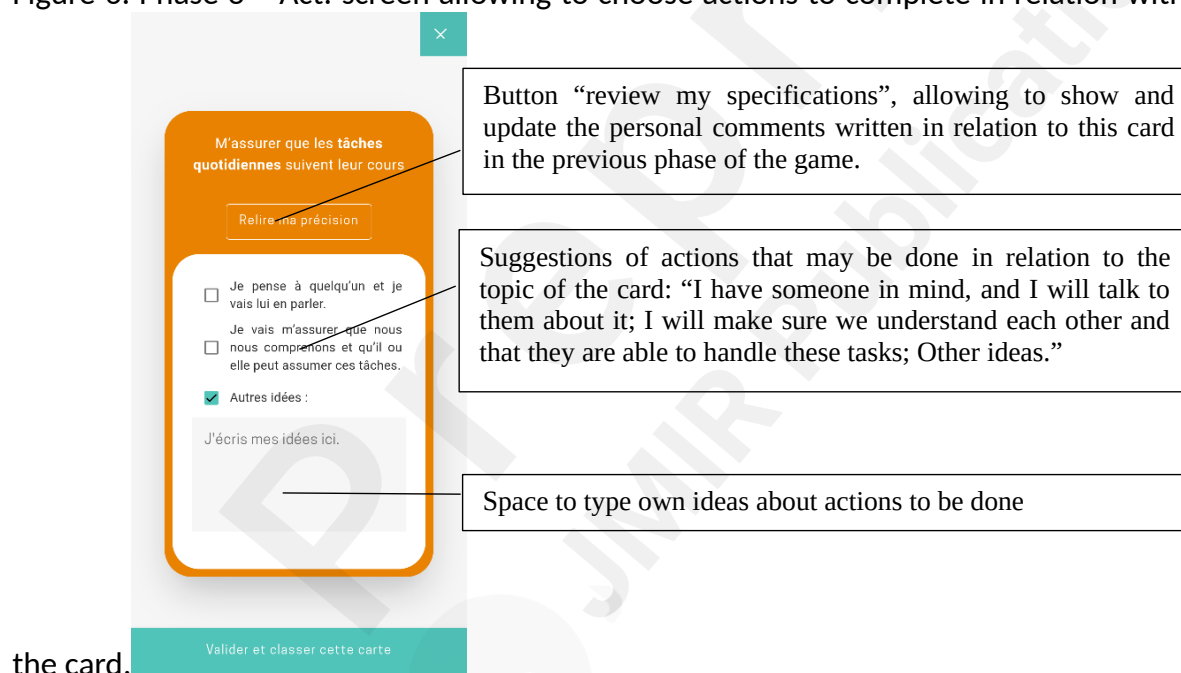


Figure 6. Phase 3 – Act: screen allowing to choose actions to complete in relation with the topic of



Methods

Recruitment

The aim was to collect data from 10 participants, as Nielsen & Landauer (1993) demonstrated that a test conducted with 10 users reveals over 98% of usability issues. The inclusion criteria were the following: being an adult, having oral and written proficiency in French, and feeling comfortable using a smartphone. A single exclusion criterion was applied: participants should not be familiar with or have previously navigated the *Accordons-nous* module in the *Concerto* app. The exclusion criterion was enforced to prevent testers from being biased by prior knowledge that could facilitate ease of use. The sample included a diversity in gender and age to ensure representativeness of the

target user audience. Participants were recruited through the patients-as-partner platform at the HUG, snowball sampling, and networking. Participation was voluntary, and participants received the information sheet and consent form in advance.

Ethics Approval, Consent, and Data Management

The research protocol was submitted to the Geneva Commission Cantonale d’Ethique de la Recherche (Req-ID 2024-00994), who decided that the project does not fall within the scope of the Human Research Ordinance and therefore waived the need for ethical approval (decision date: 17.09.2024). This study was conducted in accordance with the Declaration of Helsinki. Willing participants were informed of the study aims and procedures and signed an informed consent form. During the data collection and analysis phase, only three authors (DC, FE, and CC) had access to the recorded interviews. The recordings were destroyed after analysis. No identifying information was kept in the remaining work files.

Study Intervention

The whole evaluation was conducted online (via email and videoconference using the program Zoom). Participants received in advance via email the information and consent form along with instructions on how to join the videoconference with the experimenter and how to install the *Concerto* app. Participants were asked not to use the *Concerto* app prior to the test and they were not informed about the name of the game, nor where to find it in the app. On the day of the test, the experimenter answered any questions, made sure that informed consent was signed and sent back, and connected participants’ phone to the Zoom videoconference in order to see and record their navigation behaviour.

The test began with a few demographic and technical questions (age, gender, level of education, type of phone used, phone usage) before showing a screenshot of the game in order to collect participants’ first impressions. This was followed by a series of think-aloud tasks¹⁷ during which participants used the main functions of the game. 26 tasks were designed to evaluate the usability of the game, ensuring that an average user is able to navigate effectively through it. Participants were asked to imagine being 50-year-old person concerned with the topic of illness and advance directives, who is advised to use the game *Anticip’action*. The experimenter then formulated the scripted task instructions, one by one (described in Table 1). While completing the tasks, participants were encouraged to verbalize their thoughts, actions, and decisions.

Table 1. List and description of the tasks used during the think-aloud procedure.

Task name	Expected achievement	Exact wording of the instruction	Task considered as completed when
1. Find and Open the Game	Find the game which is nested in the module <i>Accordons-nous</i> in the <i>Concerto</i> application	Your friend told you about the game. He told you that the game is in Concerto. You are now in Concerto. More precisely, the game is in the <i>Accordons-nous</i> module. Your first task is to find the game and open it. Let’s go!	open the application <i>Concerto</i> ; scroll & click on the module <i>Accordons-nous</i> ; click on the “talk about it” menu at the bottom of the screen which displays an entry to the game; clicks on the “play” button
2. Read Rules and Start	understand the logic of the welcome page which includes the rules of game and the	First, read the rules and start the game.	click on the “game rules” button; close the rules by clicking on the X button; click on the “new game” button; when the pop-up

	entry to begin a game (Fig 1)		instruction message appears, read the instructions and close the pop-up
3. Select Feelings & Relationships	understand that there are 4 thematic card piles that can be opened (Fig 2)	Select the "Feelings and relationship" pile and open it.	click on the third pink icon at the bottom which represents the "Feelings and relationship" pile
4. Flip the First Card	understand that the card can be returned to obtain more information on the topic (Fig 3)	Flip the first card.	click on the vice-versa icon at the top of the card
5. Scroll Through Cards	understand that the content of the opened pile can be explored by scrolling (Fig 3)	Scroll the card once to the left and once to the right to see the other cards in this pile.	scroll through the cards to see the next ones from right to left, or click on the arrows at the sides of the cards
6. Classify as "Unsure"	understand the classification system including the "unsure" category (Fig 3)	Classify the first card under "unsure".	click on the rectangular button called "unsure"
7. Classify as "Very Important"	understand that the first full heart icon represents the "very important" category (Fig 3)	Classify the next three cards as "very important".	click on the full heart button
8. Exit the Pile	understand how to return to the main screen of the game when a pile is opened (Fig 3)	Exit this pile.	clicks on the X icon on the top right of the screen
9. Open Practical Questions Pile	discover another thematic card pile (Fig 2)	Open the "Practical questions" pile	click on the second orange icon at the bottom of the screen
10. Classify 9 Cards as "Very Important"	discover the rule of a maximum of ten cards classified in the "very important" category (Fig 3)	Classify the first nine cards as "very important"	click on the full heart button until a pop-up message appears
11. Read and Close Pop-Up	understand and close an instruction pop-up	[Pop-up appears] Read this message and close it.	read the message and click either on the X icon or on the "understood" button
12. Find and Scroll Surplus Cards	discover where to find already classified cards (Fig 2&4)	Find the surplus cards and scroll through them.	clicks on the X button on the right of the screen to exit the pile; on the main screen, click on "Prioritized cards" button-icons (top left) to consult and update classified cards; click on the "very important" cards menu; scroll through the cards
13. Classify Surplus Cards as "Important"	understand how to re-classify cards in another category (Fig 4)	Classify the surplus cards as "important" and then confirm.	click on a card classified as "very important"; click on the half-full heart; repeat the same
14. Classify all cards	understand that all cards must be classified in the first "Prioritize" phase of the game (Fig 2)	Classify the following cards as "not important."	click on staples containing cards & click on empty heart; repeat until no more cards are available
15. Check Card Count in Each Category	understand the logic of the four classification categories and their associated numbers, located on the main screen (Fig 2)	Do you know how many cards are present in each classification category ("very important", "important", "not important", "unsure")?	read and interpret the classification numbers located under the category's icons
16. Go to Next Phase of the Game	understand how to go to the second phase of the game	You can proceed to the next step.	click on the "next step" button located (it appears at the bottom of the main screen when all cards are classified)
17. Read Instructions and Continue	discover the game rules for the next phase ("specify") of the game	[Pop-up appears] Read the instructions and continue the game.	read the instructions & close the pop-up by click on the X or on the "understood" button
18. Add Text to	understand how to write on a	Specify the first card by	click on the staple (which opens the first

a Card	card (Fig 5)	adding text in the designated space (e.g., a letter).	"very important" card); touch the text space on the card; type text
19. Validate and Define Whether to Act	understand that the specification on a card can only be validated once it is additionally specified whether something should be done about that topic or whether it is already resolved (Fig 5)	Validate the card to move on to the next one, knowing that actions still need to be resolved.	clicks on the second radio button (e.g. "I have to look after it"); click on the "validate and classify this card" button
20. Locate the Rules	find where to display the rules of the game at any time during the game (Fig 2)	Imagine that you suddenly have doubts about some game rules and would like to consult them. Where do you find the rules of the game?	clicks on the X icon to exit the pile; on the main screen, click on "?" the icon (top left) possible alternative: quit the game with click on X on the main screen; click on "game rules" button in the welcome page
21. Validate as "Resolved"	understand that for all cards in the "specify" phase, a decision has to be made about whether it calls for an action (or not) (Fig 5)	Validate the following cards (without specifying them) as "resolved" and continue the game.	click on the pile of cards not yet specified (located at the bottom of the main screen); for each card, click on the first radio button (e.g. "It is settled"); click on the button "validate and classify this card"
22. Review and Check All Actions	understand how to handle the cards remaining in the final phase ("act") of the game: open each card, reread specifications and choose related actions (Fig 6)	Review your specifications and check all the boxes.	click on the pile of cards to be acted upon (located at the bottom of the main screen); click on "reread my specifications" button; click on the turn the card again; click on all action boxes
23. Add More Text to a Card	understand how to write own ideas about actions to be done (Fig 6)	Add text in the designated space (e.g., a letter).	click in the "other ideas" text box; type text
24. Validate the Card	understand how to validate action choices related to a card (Fig 6)	Validate the card.	clicks on the "validate and classify this card" button
25. Export Results and Return	understand how to export a summary of the game	Export your results and return to the game.	click on the "export game summary" button (it appears when all actions have been defined); read the data confidentiality pop-up and clicks on the "understood" button
26. Erase Data and Exit the Game	understand that a decision can be made about erasing the data (or keeping them) while quitting the game	Exit the game and delete the data.	click on the "quit" button: a pop-up appears: click on the "quit and delete my data" grey band

Finally, post-test questionnaires were conducted to collect participants' feedback on the usability, attractiveness, relevance and subjective endorsement of the game, as well as open questions to explore usability issues (Supplementary File 1).

Measures Used and Data Analysis

First Impressions

The 5-second test¹⁸ was used to gather users' spontaneous first impressions of the system. The test consisted in showing the main screen of the game (Figure 2) for exactly 5 seconds, after which it

was replaced by a black screen. Participants were then asked four questions: 1) What do they remember about the visual elements of the interface? 2) What do they think are the objectives of the game? 3) What is their overall impression of the game (on a 5-point scale ranging from very bad to very good)? 4) How do they evaluate the aesthetics of the game's (on a 5-point scale ranging from very unsightly to very attractive). The two open-ended questions were presented first, as this has been shown to better support memory recall.¹⁹

Think Aloud Procedure

Task Success

Performance was assessed by calculating the number of participants who succeeded or failed in completing the tasks, with or without assistance from the experimenter. The scoring system applied was as follows: 0) The participant failed, and the experimenter ultimately provided the answer; 1) The participant succeeded but only with the experimenter's help; 2) The participant succeeded with the experimenter's repetition (if the task was forgotten, not as a form of help); 3) The participant succeeded independently but explored before finding the correct result (right result, right path, but some exploration beforehand); 4) The participant succeeded but did not use the shortest path (right result, alternative route); 5) The participant succeeded without assistance and easily found the shortest path.

Clicks to Complete Tasks

The number of clicks required to complete each task was recorded. As illustrated in Table 1, some tasks required more clicks than others, and for certain tasks, multiple response paths were possible.

Time Spent on Tasks

The number of seconds that participants took to complete each task was calculated. The timing began when the experimenter finished asking the question for the first time and ended when the participant successfully completed the task. Time that participants spent digressing during the task (e.g., making critical comments about the game's design, sharing a personal memory) was recorded as 'digression time' and subtracted from the total time.

Analysis of Errors and Problems Encountered

The errors and problems encountered by participants while completing the twenty-six tasks were recorded and analysed. Each issue was documented in an Excel file, categorized according to Bastien and Scapin's heuristics (such as information density, consistency, and code meaning)²⁰, and evaluated using a 0-4 severity rate based on Nielsen & Laudauer recommendations²¹: 0) disagreement on whether it constitutes a usability problem; 1) cosmetic issue: does not require correction unless extra time is available; 2) minor usability issue: fixing this problem should be a low priority; 3) Major usability issue: important to fix, so should be a high priority; 4) Usability catastrophe: must fix this issue before the product can be launched.

Data Analysis

To ensure reliability, all authors coded two recordings independently. Results were then compared and discussed to resolve discrepancies or doubts about specific interpretations. The first author coded the remaining data independently.

Questionnaires

Usability Assessment

The French version of the standardized System Usability Scale (SUS) was used to evaluate the

usability of the game²². This questionnaire offers an indication of the effectiveness, efficiency, and overall ease of use of a digital product. It includes ten 0-4 Likert-scale questions and outputs a score ranging from 0 to 100 (each question contributing up to 10 points). A score around 85 is considered excellent, around 72 good, around 53 average, and around 38 poor.

Since discussing end-of-life issues are not everyday activities, *Anticip'action* is not expected to be played repetitively. Consequently, the first question of the SUS, "I think I would like to use this system frequently", is mildly suited to evaluate the game. A slightly modified version of that question was therefore added the original ten items: "I think that if I need to consider what is important for my end of life, I would give priority to this game." This adjustment allowed to calculate two SUS scores: the original and the one with the modified item.

Attractiveness

The French version of the standardized 28 items AttrakDiff questionnaire²³ was used to evaluate users' experience across four dimensions, each containing 7 items: 1) Pragmatic quality, which measures the product's usability and the perceived ease with which users can achieve their goals; 2) Hedonic-stimulation quality, which assesses the extent to which the product satisfies the need for stimulation by offering new, interesting, and engaging content, features, and interaction styles; 3) Hedonic-identity quality, which examines how well the product supports a social function and communicates a sense of user identity; and 4) Overall attractiveness, which represents the perceived value of the product based on its pragmatic and hedonic qualities. This questionnaire includes pairs of contrasting words, rated on a 7-point scale ranging from -3 to +3. Scores close to the mean (between 0 and 1) indicate that the product achieves its objectives without any significant negative impact, although improvements could be made to create a more positive user experience or attractiveness. Scores outside the neutral zone should be interpreted as either positive (from 1 to 3) or negative (from -1 to -3).

Relevance and Endorsement

To obtain participants' evaluation of the impact of the application on user's awareness, knowledge, attitudes, intentions to change, and likelihood of actual change in advance care planning behaviour, the six "perceived impact" items (section F) of the validated MARS questionnaire (Mobile Application Rating Scale) was used²⁴. It allows calculating the overall mean 5-point Likert scores to be interpreted as follows: 1) inadequate; 2) poor; 3) acceptable; 4) good, 5) excellent. To observe whether participants endorse the game, the first 5-point Likert item of the MARS "subjective quality" (section E, first question) was used, asking participants whether they would recommend this game to persons who could benefit from it. This questionnaire was translated in French following the good practices described in Wild et al.²⁵

Participants' Qualitative Feedback

At the end of the study, participants were asked five open-ended questions to gather their final feedback on the game. These questions aimed to assess 1) what participants appreciated about the game, 2) what aspects they disliked, 3) which tasks they found particularly challenging, 4) what they felt was missing in the game, and 5) whether they had any additional comments to share. To analyse the responses, the guidelines set by Mucchielli and Paillé²⁶ for qualitative data analysis were followed. Specifically, the Excel program was used for organizing and working with the material, using integrated notes within the text that were differentiated by colours to facilitate categorization. A continuous thematic analysis approach was applied to systematically identify emerging themes and patterns throughout the feedback.

Content Readability

To assess the readability of the textual content of the game, the text was compiled in a word document and evaluated with the Scolarius test²⁷. This test was developed by Influence Communication, a Canadian media analysis organization. The readability score is calculated similarly to the Flesch Reading Ease score (commonly used for English-language materials). It measures word and paragraph length to provide a score ranging from 50 to 250, which is interpreted as follows: a score between 50 and 89 corresponds to a elementary school reading level, 90 to 119 indicates a high school level, 120 to 149 reflects a college level, and 150 to 189+ represents a university level.

Results

Participant Characteristics

The procedure was pilot tested with 2 participants in order to master the technical aspects (online test with multiple devices) and refine the multiple tasks instructions. These data are not included in the results. 12 participants were included in the test, but the data of 2 participants could not be analysed due to major technical issues: a failure of the screen-sharing functionality on Zoom in one case and bad quality recording in the other case. The final dataset includes complete responses from 10 participants.

Participants were aged between 25 and 59, and presented a diversity in gender, higher educational background, and type of device used (see Table 2). All participants reported using their smartphones daily, demonstrating familiarity with digital interfaces and technological tools.

Table 2. Participants' characteristics.

<i>Participant</i>	<i>Gender</i>	<i>Age</i>	<i>Education</i>	<i>Smartphone used</i>
P1	female	54	Professional higher education	IOS
P2	female	25	University	IOS
P3	female	35	Professional higher education	IOS
P4	male	53	High school (College)	IOS
P5 ^a	female	36	High school (College)	IOS
P6	male	34	High school (College)	android
P7 ^a	male	59	University	IOS
P8	male	35	University	android
P9	female	32	University	IOS
P10	male	27	University	IOS
P11	male	65	University	IOS
P12	female	49	University	IOS

^a Data from these participants could not be used because of technical issues

First Impressions

On the recalling visual elements task, 8/10 participants noticed the presence of coloured cards; of these, 3 noted that the cards had titles, and 2 observed numbers in the centre of each card. The second most frequently recalled element (5/10) was the instruction bubble positioned in the middle of the screen. Finally, the three circular button-icons representing the three phases of the game

were remembered by 5 participants; within this group, 3 also noticed greyed-out images of cards, and another 3 noticed the text beneath the icons. Some elements remained unnoticed, including the grey background of the game, the title of the game phase at the top of the screen, the two square-buttons on the right and left to access the rules or exit the game, the classification symbols (heart symbols and question mark), and the numbers below those symbols. Some participants had false memories: one remembered the presence of a question (which might have been confused with the instruction bubble in the middle of the screen), another reported fourth button-icons at the top of the screen (instead of three), and a latter mentioned "choices with several options," possibly referring to the instructions and hearts. Additionally, there was evidence of imprecise recall and potential misinterpretation of certain elements. For example, one participant described a white background for the game, another reported that the coloured cards were placed in the middle of the screen (instead of the bottom). Similarly, another participant misremembered the position of the text as being below the cards rather than above them.

Regarding participants' understanding of the objectives of the game, 5 were unable to provide an answer, while the remaining 5 identified it as a card game. Of those who recognized it as a card game, 3 suggested that the objective might involve making choices. Each of the five participants provided different interpretations of the game: asking questions about various hospital-related topics, completing a multiple-choice quiz, associating each card stack with a specific value, obtaining information with the option to change one's mind, sorting cards by theme, and clicking on hearts to indicate preferences (this participant thus seems to recall the presence of the hearts even if this was not explicitly expressed in the visual recalling task).

Participants' general impression of the game was mixed: 4/10 rated it as good, 3 as average, 2 as bad, and 1 as very bad.

Evaluation of the aesthetics of the game was also mixed: 1/10 found it very attractive, 2 rated it as attractive, 5 as neither attractive nor unsightly, 1 as unsightly, and 1 as very unsightly.

Think Aloud Tasks evaluation

Task success

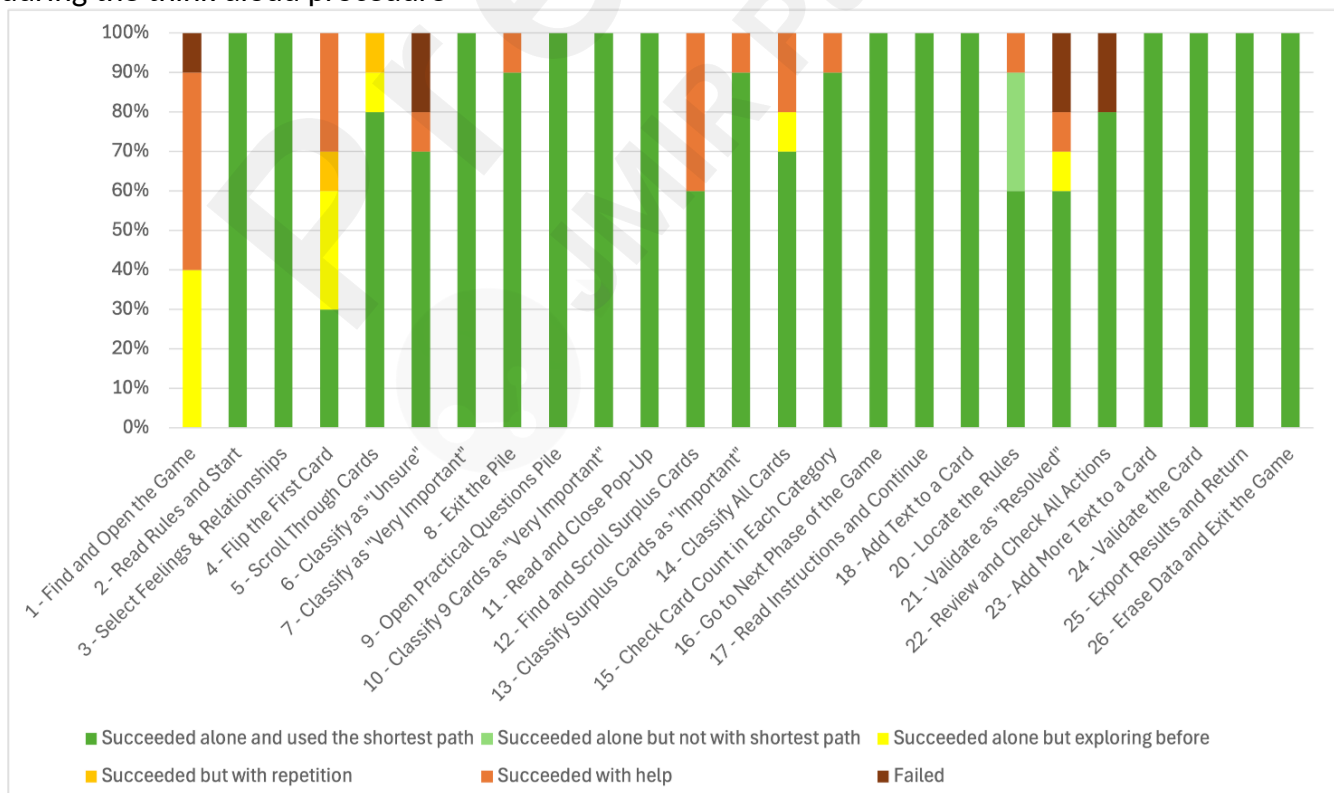
At analysis stage, task 19 (which is partly redundant with task 21) was excluded from the results because it appeared that most participants failed to understand the instructions due to a suboptimal phrasing of the task: the instruction sentence started with "validate the card" before unclearly alluding to the constraint that a card can only be validated once a decision has been made about whether one should do, or not, something about the topic of the card. Consequently, participants attempted to validate the card prematurely, before ticking the box that an action should be planned in relation to the topic of the card. Unfortunately, this methodological error was not spotted during the pilot tests.

As illustrated in Figure 7, and Supplementary Table S1, most tasks were completed successfully by all participants (21/25), and some required assistance. In 83.2% of the cases (208/250), participants successfully completed tasks without assistance and found the shortest path. In 1.2% of cases (3/250), participants succeeded independently but did not follow the most direct route. In 4% of cases (10/250), participants explored the interface before finding the correct solution. Meanwhile, 8.8% of cases (22/250) required intervention from the experimenter. Finally, 2.8% of cases (7/250) resulted in failure, as participants were unable to complete the tasks, even with assistance.

Some tasks required minimal assistance (e.g. Task 4, Task 14) while other tasks presented notable usability issues (see complementary descriptions in Table 4). In particular, for completing Task 1 which was about finding the game in the Concerto app, 6 participants required assistance such as

repeating the instructions, hints, additional information, or direct answer. For Task 4, which was about flipping the card, 6 participants experienced difficulties spotting the dedicated button (see Figure 3). For Task 6 which was about classifying a card in the category “unsure”, 3 participants needed substantial intervention (additional information, guiding questions, or answers to questions) to understand that the square button “unsure” is a clickable category button, although the other clickable categories are round buttons (see Figure 3). For Task 12 which was about finding the too numerous cards that were classified in the “very important” category, 6 participants faced difficulties, necessitating multiple forms of assistance such as instruction repetition, additional information, hints, answers to participants’ questions, or guiding questions. However, the type of input needed indicates that the wording of the instruction was not optimal: the words “cartes en surplus” (“surplus cards”) used in the instruction could be misleadingly interpreted as the existence of some “extra cards” in the game, although the aim was to convey the information that “too many cards were allocated to the “very important” category and some need to be removed from the category before moving on to the next phase of the game. Task 21 was also challenging for 3 participants. It required to understand that for all cards in the “specify” phase of the game, a decision had to be made about whether the cards call for an action (or not) before “resolving” them and proceeding to the action phase of the game (see Figure 5). The formulation of the instructions for this task however, was short and allusive, which could explain part of the need for more guidance. In task 22, one participant failed to understand that the pile in the centre needs to be resolved, and another participant failed to click on the “review my specifications” button to check the specifications related to the card (see figure 6). The experimenter provided the answer in both cases.

Figure 7. Proportion of participants who succeeded or failed to complete study tasks with or without input from the experimenter, the type of input and with or without using the shortest path during the think-aloud procedure



Clicks to Complete Tasks

As illustrated in Table 3, participants' clicks compared to expected optimal number of clicks reveals varying levels of efficiency across tasks. For most tasks, participants generally stayed close to the minimal number of expected clicks, indicating a solid understanding of the interface and task requirements. However, several tasks stand out with higher click counts, suggesting areas where participants may have encountered challenges or required additional exploration to complete the task. In particular, Task 1, which was about finding the game in the Concerto app was completed with an average of 10.3 clicks compared to the expected number of 3.

Table 3. Overall participants' click performance per task: average number of clicks used to complete the task, expected optimal number of clicks, standard deviation, and deviation from the optimal number.

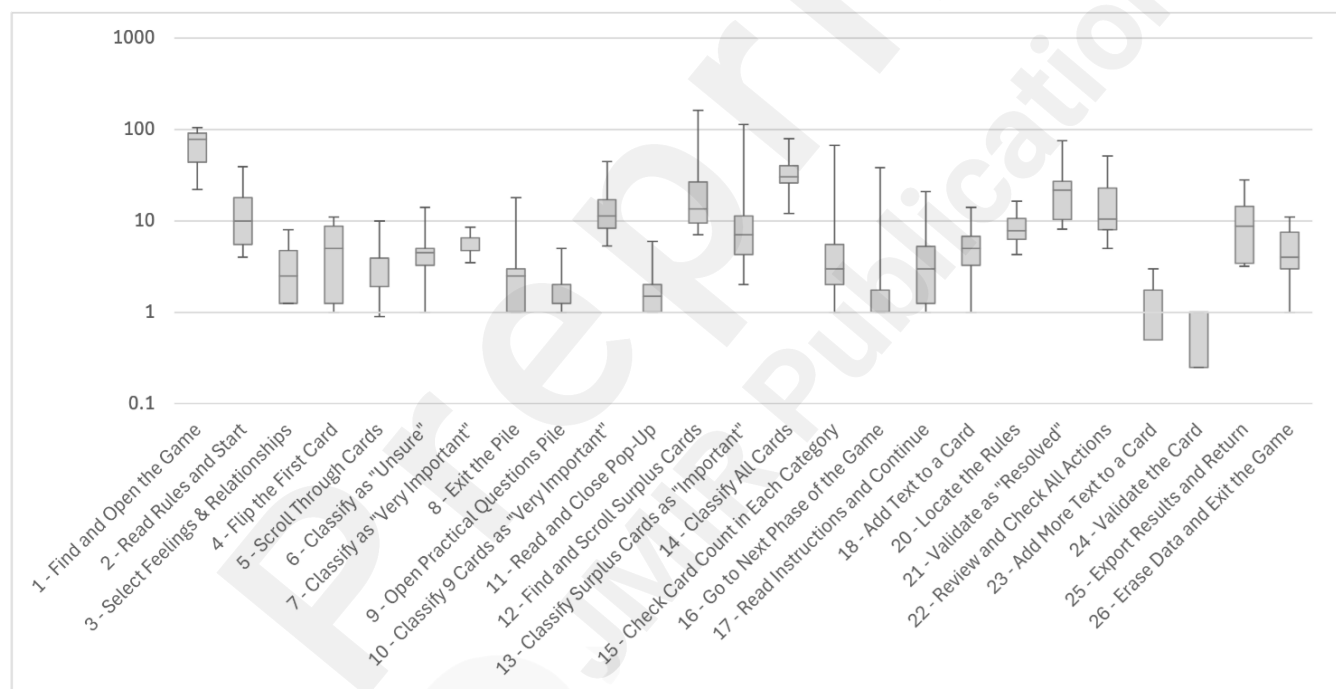
Task	Average	Standard deviation	Optimal nb of clicks	Difference
1. Find and Open the Game	10,30	4,47	3,00	7,30
2. Read Rules and Start	4,00	0,00	4,00	0,00
3. Select Feelings & Relationships	1,00	0,00	1,00	0,00
4. Flip the First Card	2,50	1,43	1,00	1,50
5. Scroll Through Cards	3,00	1,70	2,00	1,00
6. Classify as "Unsure"	2,40	2,84	1,00	1,40
7. Classify as "Very Important"	3,20	0,42	3,00	0,20
8. Exit the Pile	1,20	0,63	1,00	0,20
9. Open Practical Questions Pile	1,00	0,00	1,00	0,00
10. Classify 9 Cards as "Very Important"	8,10	0,32	8,00	0,10
11. Read and Close Pop-Up	1,00	0,00	1,00	0,00
12. Find and Scroll Surplus Cards	5,20	2,30	4,00	1,20
13. Classify Surplus Cards as "Important"	3,40	0,97	3,00	0,40
14. Classify all cards	25,40	0,97	25,00	0,40
15. Check Card Count in Each Category	0,00	0,00	0,00	0,00
16. Go to Next Phase of the Game	1,00	0,00	1,00	0,00
17. Read Instructions and Continue	1,00	0,00	1,00	0,00
18. Add Text to a Card	2,70	0,95	2,00	0,70
20. Locate the Rules	2,40	0,52	2,00	0,40
21. Validate as "Resolved"	20,30	2,26	19,00	1,30
22. Review and Check All Actions	6,30	3,13	5,00	1,30
23. Add More Text to a Card	2,40	0,70	2,00	0,40
24. Validate the Card	1,00	0,00	1,00	0,00
25. Export Results and Return	3,00	0,00	3,00	0,00
26. Erase Data and Exit the Game	2,00	0,00	2,00	0,00

Time Spent on Tasks

As illustrated in Figure 8, the analysis of time allocation per task reveals substantial variability among participants. Nevertheless, some patterns and deviations from pre-calculated optimal times

provide insight into specific usability challenges. Notably, Task 1 ("Find and open the game") required considerably more time than anticipated, indicating that participants faced initial difficulties with the game's discoverability. Participants 6 and 8 displayed markedly extended times for Task 1 suggesting that the entry point for locating the game lacks intuitive visibility or clarity. Divergence from optimal could also be observed related to Tasks 10, 14 and 21 which required to categorize or resolve numerous cards into categories. By design, these were lengthy rather than a task causing navigation difficulties: while some participants elected to read each card prior to sorting it, others processed the task more quickly without detailed review, leading to significant individual variations in completion time. A similar pattern could be observed with Task 2 which asked to read the rules of the game and start: some participants took much more time to read than others. Time for completing Tasks 12 and 21 (which are discussed above) also diverged notably from optimal times, partly due to issues stemming from unclear instructions, and partly due to suboptimal guidance in the game.

Figure 8. Mean time (in seconds) spent by participants for completing each of the 25 tasks during the think-aloud procedure, displayed on a logarithmic scale.



Errors and Problems Encountered

Following Bastien and Scapin criteria²⁰, we recorded 23 Problems encountered by the participants while completing the 26 tasks (see Table 4). Of these problems, 8.7% (2/23) were considered as a usability catastrophe, 30.4% (7/23) as major usability problems, 21.7% (5/23) as minor usability problems, 26.1% (6/23) as a cosmetic issue and the last 13.0% (3/23) as no usability problem. A clear majority of these problems (14/23) is related to guidance difficulties such as the visibility of visual items or the way they are displayed to indicate their relation to each other.

Table 4. Description of problems encountered by participants during the think-aloud tasks, frequency of occurrence of these problems (number of participants affected/total of participants), qualification of the problems with Bastien & Scapin categories, and evaluation of their severity with

Nielsen 1-4 rate.

Task	Item	Problems encountered by participants	Frequency	Category	Severity
			Nb/Total	Bastien & Scapin	Nielsen
1. Find and Open the Game	1.1	could not find the game and clicked on the wrong tab	3/10	Guidance: grouping/distinction	4
	1.2	could not find the game: did not see the menu at the bottom	2/10	Guidance: grouping/distinction, Consistency	4
	1.3	thought they were already in the game while they were on the wrong page in <i>Accordons-nous</i>	2/10	Guidance: Prompting, Workload: information density	3
	1.4	complained about too much text	1/10	Workload: information density	1
	1.5	did not see the "play" button which allows to enter in the game	1/10	Guidance: Legibility	3
	1.6	misunderstood the tab " <i>Anticip'action</i> " with as a way to enter the game (although it is a tab to navigate within sections in the <i>Accordons-nous</i> module)	2/10	Guidance: grouping/distinction	3
2. Read Rules and Start	2.1	felt overwhelmed by the text	2/10	Workload: information density	1
4. Flip the First Card	4.1	did not see the button to flip the card	4/10	Guidance: grouping/distinction, Compatibility	3
	4.2	interpreted the return icon as a door to return to the menu	1/10	Consistency	1
	4.3	interpreted the card title as a clickable button	1/10	Consistency	0
6. Classify as "Unsure"	6.1	used drag and drop to classify a card (which is not a function in the game)	2/10	Compatibility, Consistency	1
	6.2	clicked on the wrong button	2/10	Significance of codes, consistency	2
8. Exit the Pile	8.1	did not see the X button (located on the top right) to exit the stack	1/10	Guidance: prompting	0
12. Find and Scroll Surplus Cards	12.1	tried to find the extra cards by clicking on the hearts on the main page (which does not function in the game)	3/10	Guidance: grouping/distinction + prompting, Significance of codes	3
	12.2	couldn't find the extra cards after exploring the screen	6/10	Guidance: grouping/distinction, Consistency	3
13. Classify Surplus Cards as "Important"	13.1	did not see the confirmation button after having completed the task	1/10	Workload: minimal actions, Adaptability: flexibility	2
18. Add Text to a Card	18.1	did not understand that to validate the written text, one needs to click on the X button	1/10	Compatibility, Guidance: prompting	2

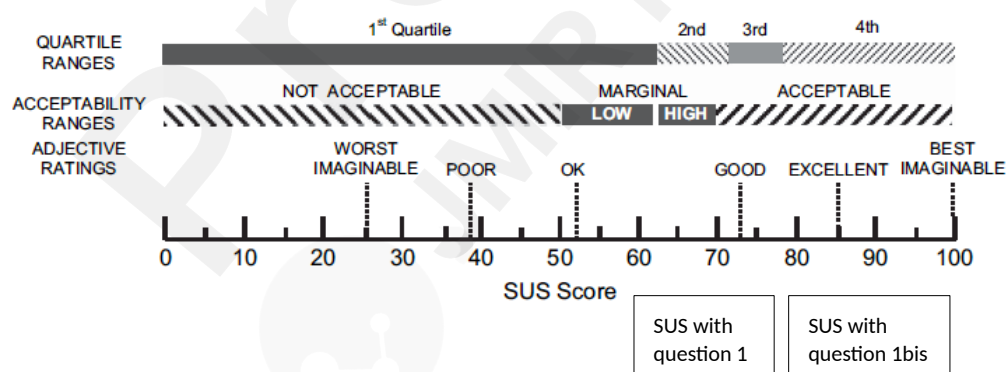
	18.2	clicked in the text area while only the written area was active	1/10	Compatibility	1
20. Locate the Rules	20.1	did not see the button to find the rules	3/10	Guidance: Legibility	1
	20.2	did not want to exit the game for fear of losing data	1/10	Error Management: error protection, Workload: information density	2
21. Validate as "Resolved"	21.1	did not click on the stack in phase 2 to continue the game	1/10	Workload: information density, Guidance: grouping/distinction	0
22. Review and Check All Boxes	22.1	clicked on the specified cards button instead of the blue stack at the bottom	1/10	Guidance: prompting, Significance of codes	1
	22.2	did not see the button to reread the details	2/10	Guidance: immediate feedback+ legibility, Significance of codes	3

Questionnaires

Usability Assessment

As illustrated in Figure 9, the mean score of the original SUS questionnaire was 77.75, while the score of the adapted SUS questionnaire (containing a more fitting variant of the first question) resulted in a slightly higher mean score of 79.25, indicating that the game was evaluated between good and excellent.

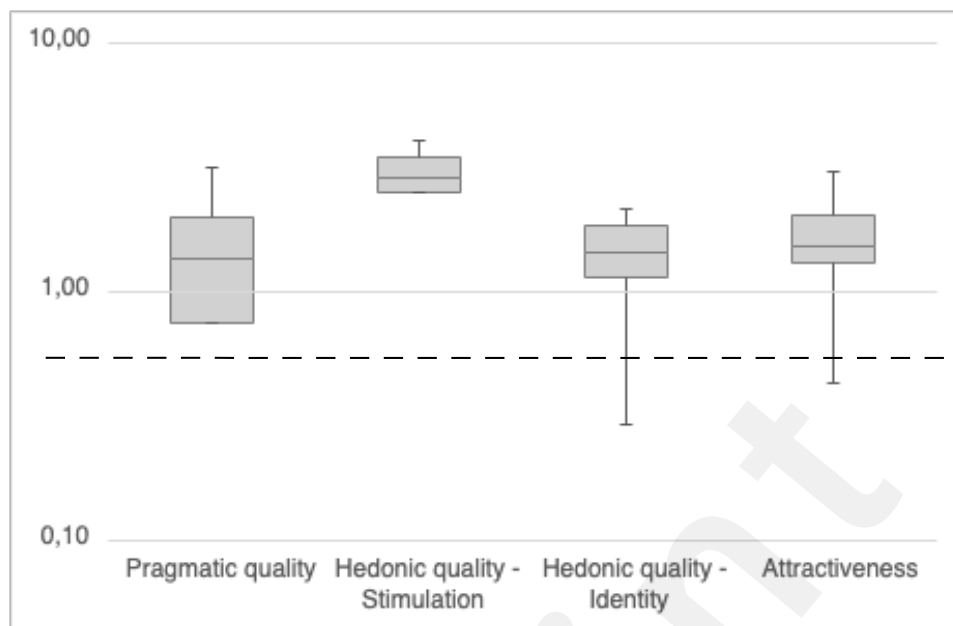
Figure 9. Score of the game *Anticip'action* on the original and updated versions of the System Usability Scale.



Attractiveness

The game obtained a global attractiveness score of 1.57, indicating an overall positive assessment. As illustrated in Figure 10, positive results were obtained on all four dimensions of the test, ranging from 1.16 to 1.57.

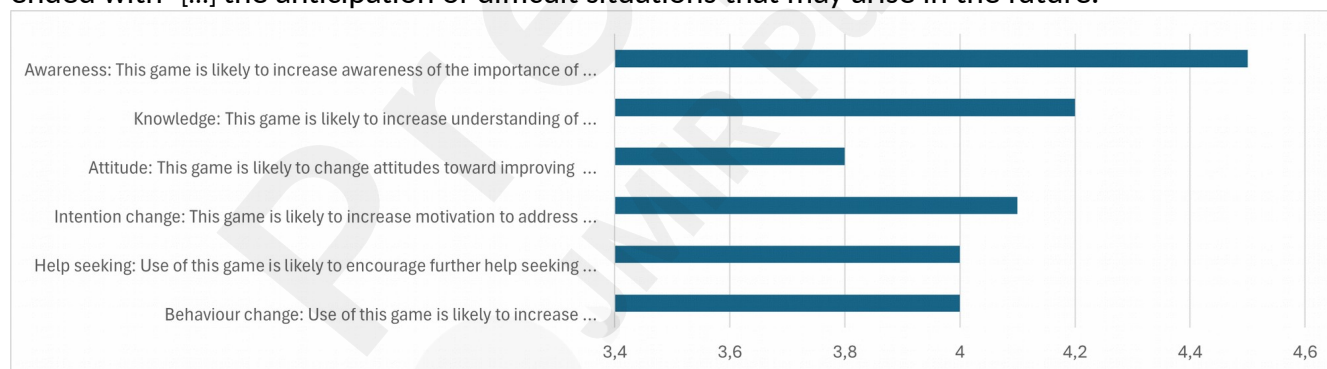
Figure 10. Mean scores of the game *Anticip'action* on the four dimensions of the AttrakDiff questionnaire, displayed on a logarithmic scale.



Relevance and Endorsement

The overall mean score of the MARS questionnaire was 4.1, indicating that participants evaluated the relevance of the game as good. As illustrated in Figure 11, participants were mostly convinced that the game can increase awareness, knowledge and intention change regarding the topic of anticipating difficult situations that may arise in the future.

Figure 11: Average responses of participants to the 6 items of the MARS questionnaire. All questions ended with “[...] the anticipation of difficult situations that may arise in the future.”



The game also ranked positively on the “I would recommend” question: overall 3.3 score with 2 participants indicating that they would highly recommend the game to everyone who could benefit from it, and 1 would recommend it to many people, 5 to several people, and 2 to very few people. None would not recommend the game.

Participants' Qualitative Feedback

Participants generally provided positive feedback about the game. Most found it user-friendly, with clear visuals and easy navigation. Seven participants highlighted that the game addresses the sensitive topic of advanced directives and end-of-life care in an approachable and meaningful way. Six participants reported that the game encourages reflection on complex health-related issues and promotes awareness of often-overlooked topics.

Areas for improvement were also discussed. Several participants reported feeling overwhelmed by the amount of information and recommended adjustments to reduce cognitive load. They suggested adding an onboarding tutorial to help users understand the game's mechanics. Some participants thought that personalized content options (e.g. an option to filter cards that are more relevant to users' profile) may help to better tailor the game to individual user's needs. Navigation issues were also discussed: the "usure" and the card-flipping buttons are not visually intuitive as clickable elements, and navigation could be improved with clearer visual cues such as more prominent buttons. Moreover, some participants recommended implementing dynamic features such as animations, which could increase accessibility and maintain engagement during the play. Finally, several participants felt that the term "jeu" ("game") does not fit with the seriousness of the content and suggested some rephrasing or warning to prepare users for the sensitive discussions that the playing can generate.

Content Readability

The readability analysis of the cards in the game, assessed with the Scolarius program, yielded distinct scores for the rectos (card titles) and versos (explanations). The rectos scored an average of 50.5, calculated as the mean of the scores across all recto cards, indicating that they are accessible to individuals with an elementary school education. In contrast, the versos scored 119.8, which corresponds to a high school reading level. In detail, 20/33 verso cards required elementary school level 6/33 a high school level and 7/33 a university-level.

Modifications to Make Based on Results

Analysis of the 23 usability issues and the ways to address them (detailed in Table 5) showed that most issues were related to the identification of which visual elements are actionable, and which are not: some buttons were not always interpreted as clickable while some titles were occasionally confused with buttons. No substantial structural modifications seem to be required to address the usability issues except for the location of the game which is currently nested in a section of a module (*Accordons-nous*) of an app (*Concerto*), and therefore difficult to access in the first place.

Table 5. List of changes to make to the game in response to the issues identified.

<i>Item</i>	<i>Problems encountered by participants</i>	<i>Change to make</i>
1.1, 1.2, 1.3	could not find the game nested in the <i>Accordons-nous</i> module	Create a video explaining where the game is
1.4	complained about too much text	No changes to make
1.5, 1.6	did not see the "play" button which allows to enter in the game	Highlight the button by bolding "Play"
2.1	felt overwhelmed by the text	No changes to make
4.1	did not see the button to flip the card	Move the button to the corner or the bottom of the card
4.2	interpreted the return icon as a door to return to the menu	No changes to make
4.3	interpreted the card title as a clickable button	Redesign the title, for example, by removing the border
6.1	used drag and drop to classify a card (which is not a function in the game)	No changes to make
6.2	clicked on the wrong button	Align the four buttons on the same level, enlarge the question mark, move it to the centre, round the edges, use the same structure as the other

		buttons, or add a heart with a question mark in the middle and write "I am unsure" next to it
8.1	did not see the X button (located on the top right) to exit the stack	No changes to make
12.1 - 12.2	couldn't find the extra cards	Gray out the hearts or make them clickable to access the menu
13.1	did not see the confirmation button after having completed the task	Change the button design, round the edges, and ensure consistency
18.1	did not understand that to validate the written text, one needs to click on the X button	Add a button to validate the text
18.2	clicked in the text area while only the written area was active	No changes to make
20.1	did not see the button to find the rules	No changes to make
20.2	did not want to exit the game for fear of losing data	Specify more clearly that exiting the game will not result in data loss
21.1	did not click on the stack in step 2 to continue the game	No changes to make
22.1	clicked on the specified cards button instead of the blue stack at the bottom	No changes to make
22.2	did not see the button to reread the details	Redesign the button, which is too similar to the card titles, to make it more visible

Discussion

Principal Results

This study evaluated the usability, readability, and user experience of the game *Anticip'action* designed to facilitate end-of-life discussions and advance care planning decisions. It reveals overall satisfying quantitative and qualitative results.

After 5 seconds of visualization of the main screen of the game, most participants had a good or average overall impression of the game and were able to recall key visual elements, such as coloured cards and text. However, they struggled to notice other important interface components, including classification symbols and navigation buttons. Some misinterpretations of visual elements could be noticed, which was confirmed by participants' fragmented and diverse understanding of the objectives of the game. Moreover, the aesthetic of the game left participants mostly indifferent. These results indicate that there is room for improvement in the visual appearance of the game to better engage users. However, they should be put in light of the fact that in real world condition, before reaching the main game screen that was used for the 5 seconds test, users will always receive preliminary information about the content, purpose and rules of the game: the welcome page of the game includes a pictogram with cards and introductory text explaining its purpose (see Figure 1). Moreover, a pop-up explains the card sorting task and classification symbols when starting a new game.

The think aloud procedure resulted in a high overall success rate. In 83.2% of the cases (208/250), participants completed the tasks without assistance. Close performance regarding expected number of clicks confirms that the game displays clear navigation paths. For some tasks however participants required assistance, indicating the existence of serious usability problems. The analysis of the failures and difficulties encountered (23 in total) revealed that some issues were partly due to a suboptimal wording of task instructions (Task 12 & 21), that a large proportion of problems encountered (14/23) were related to guidance, and that there were 9 major usability issues that need to be addressed (see Table 4). In detail, the following tasks highlighted important difficulties

related to navigation and discoverability: Task 1 which is about finding the game in the *Concerto* app and Tasks 12 which is about finding the too numerous cards that were classified in the “very important” category and reclassify them in other categories. Numerous participants needed guidance and spent more time in completing these tasks compared to optimal expected time (as illustrated in Table 6). These elements need to be addressed with user instructions and improved visual guidance. Moreover, the test revealed occasional inconsistencies in design (some buttons were not visible enough in relation to tasks 1, 4, and 13), excessive cognitive load (some pages contain numerous elements and text), and inadequate error prevention: for example, once players have opened a pile of cards, they tended to expect that scrolling is the primary navigation method although “resolving” cards required to click on a button (Task 21). All usability issues identified could be addressed with minor modifications as highlighted in Table 5.

Table 6. Summary of relevant usability problems encountered during the think aloud test, with difference between average time spent by participants per task and expected optimal time, number of relevant usability problems encountered by participants per task, and number of participants affected by these problems

Task	Difference in seconds	Nb of problems	Nb of part. affected
1. Find and Open the Game	29	6	7
2. Read Rules and Start	7	1	2
4. Flip the First Card	2	3	5
6. Classify as "Unsure"	2	2	3
8. Exit the Pile	3	1	1
12. Find and Scroll Surplus Cards	16	2	5
13. Classify Surplus Cards as "Important"	16	1	1
18. Add Text to a Card	4	2	2
20. Locate the Rules	4	2	4
21. Validate as "Resolved"	8	1	1
22. Review and Check All Actions	5	2	3

At the end of the test, *Anticip'action* was evaluated between good and excellent on the System Usability Scale questionnaire. It obtained a high score of 77.75/100 with the original question and a higher score of 79.25 with the adapted question. The increase in score resulting from the adaptation of the first question highlights the importance of context-specific adaptations of usability assessment tools.

The game obtained an overall positive assessment on its attractiveness although there is still room for improvement. The global score of 1.57 on the AttrakDiff questionnaire reflects a generally positive perception. Scores on the pragmatic and hedonic scales ranged from 1.16 to 1.57, all above zero, indicating a baseline level of user satisfaction. The hedonic quality obtained the lowest score, suggesting that improvements could be made on this aspect to better engage users and sustain their interest. Enhancements in the design and interactive content, such as the inclusion of more visually dynamic elements in the game, could increase its attractiveness while addressing some navigation or cognitive load issues. A reduction of action per steps, notably for resorting the cards or resolving them in the “specify” phase of the game, could help to keep users’ engagement. At minima, a greater clarity and streamlining of these tasks processes would improve user experience.

Although this test includes a low number of participants and no quantitative conclusions should be drawn, we noticed that participants with greater age and those that were recruited via the patients-as-partners program at the hospital rated the game more positively. This may be due to a higher baseline positive receptivity to the topic of advance care planning discussions.

Anticip'action was also evaluated as relevant with an overall 4.1/5 score on the Mobile App Rating Scale: in detail, the game was judged as particularly impactful for raising awareness, improving knowledge, and motivating behaviour change regarding advance care planning. Participants also endorsed the game with a positive 3.3/5 score on the "I would recommend" question. Given the specificity and sensitivity of the topic, such a result is promising.

The readability analysis showed that the titles of the cards are understandable for elementary school level users which is an excellent result. However, the rectos of the cards containing longer explanations require high school reading level, indicating room for improvement. Part of the difficulty may be due to choices in gender-neutral language (which has the effect of increasing the lengths of sentences in French) and to the use of unavoidable technical terms such as surrogate decision maker, digital legacy or lasting power of attorney. Efforts are underway to streamline and simplify the content of the cards while maintaining their content value.

Participants provided overall positive qualitative feedback while pointing out aspects that could be improved.

Most found it user-friendly, with clear visuals and easy navigation. They highlighted its relevance for fostering engagement and encouraging reflection on complex topics like advance directives. Some participants however, pointed out areas that needed improvement. Their concerns included the cognitive overload, some unclarity in the navigation process related to specific tasks. They emphasized the need for an onboarding tutorial to improve accessibility, and more animations, intuitive interactive elements, clearer buttons, and personalized content pathways to improve visual clarity and users' engagement. Some participants also disagreed with the label "game" for such a conversation tool and expressed the need for providing early warnings about with the emotional sensitivity of the subject.

To address the identified issues and following participants' recommendations, several improvements are envisaged. Easy to implement solutions are detailed in Table 5. Further, modifications may include the introduction of an onboarding tutorial to enhance initial navigation and reduce cognitive load. Additional options to personalise some features of the game (e.g. relax the 10 cards stopping rule) or to filter subgroups of cards may also help to further align the game with diverse user needs and preferences. Additionally, enhancing the game's visual appeal by incorporating more dynamic features (e.g. visualisable move of cards from one staple to another) could increase engagement and satisfaction, especially among younger users.

Limitations

The test did not include participants with lower levels of education (primary school or professional school). Conclusions about this category of population can thus hardly be drawn.

The test was conducted online with the main screen view on participants' devices. Therefore, participant's facial expressions could not be used as non-verbal cues for evaluating the gravity of usability issues.

Part of the participants' failure to complete some tasks (in particular, tasks 19 that was removed from the analysis and tasks 12 and 21) may be due to poor wording of the instructions.

Some participants took more time than others to read the texts on the cards before completing the tasks. This difference in participant's behavioural style could have an important impact on the time

spent on tasks, although it is not an indication of failure to complete them. This was particularly obvious on task 14 ("Classify all cards") and may have affected tasks 10 and 21. Therefore, time measures are difficult to interpret as usability factors in this study.

Conclusions

Anticip'action is a conversation tool aimed at initiating end-of-life and advance care planning discussions and at increasing patients' empowerment during those discussions. It offers accessible content, simple navigation, and thoughtful discussion prompts to support individuals, families, and healthcare professionals in exploring these important and often challenging topics. It is also designed to motivate related action planning, such as writing advance directives.

This study evaluated the usability, readability, and user experience of the digital version of the game. The results demonstrated that participants found the game generally user-friendly, with clear visuals and intuitive navigation. Qualitative feedback highlighted its relevance. Specific challenges were identified, including cognitive overload and some unclear navigation elements. Addressing these issues through improved design, clearer instructions, and better user guidance would further enhance user experience and engagement.

Overall, the usability findings validated *Anticip'action* as a promising and meaningful tool for promoting reflection, raising awareness, and supporting advance care planning conversations. While additional testing with health care professionals and broader user groups would strengthen its evidence base, the current findings lay a strong foundation for *Anticip'action* as a valuable resource for patients, families, and caregivers navigating end-of-life decisions and planning.

Acknowledgements

The authors would like to thank everyone who contributed to the development of the game, notably (but not only) Catherine Bollondi, Marta Fadda, Samia Hurst, Pascale Lefuel, Sophie Pautex, Arnaud Ricci, Marianne Rubio, Céline Schöpfer, Inès Serre, Pierre Sutter, and Aida Yamani.

The project benefited from the financial support of the HUG and the *Fondation Privée des Hôpitaux Universitaires de Genève*, a non-profit organization that was not involved in any stage of the study.

Authors' Contributions

Conceptualization: CC, DC, FE; Software: AB, FE; Data curation: All; Resources: CC, FE; Formal analysis: DC; Supervision: CC, FE; Funding acquisition: CC; Validation: CC, FE; Investigation: DC; Visualization: AB, DC; Methodology: CC, DC, FE; Writing – original draft: CC, DC; Writing – review & editing: All; Project administration: CC, FE.

Conflicts of Interest

Anticip'action is not a saleable product. It is included in the host app Concerto Hopitaux Universitaires de Genève, which can be downloaded for free. The authors have no financial interests to declare.

Data Availability

The material and the dataset generated and analysed during the current study and are available on

the OSF repository: <https://osf.io/n3kbc>.

Appendix

Supplementary file 1 contains Table S1, questionnaires used, and discussion grid for the final qualitative feedback, in original language (French) and English translation.



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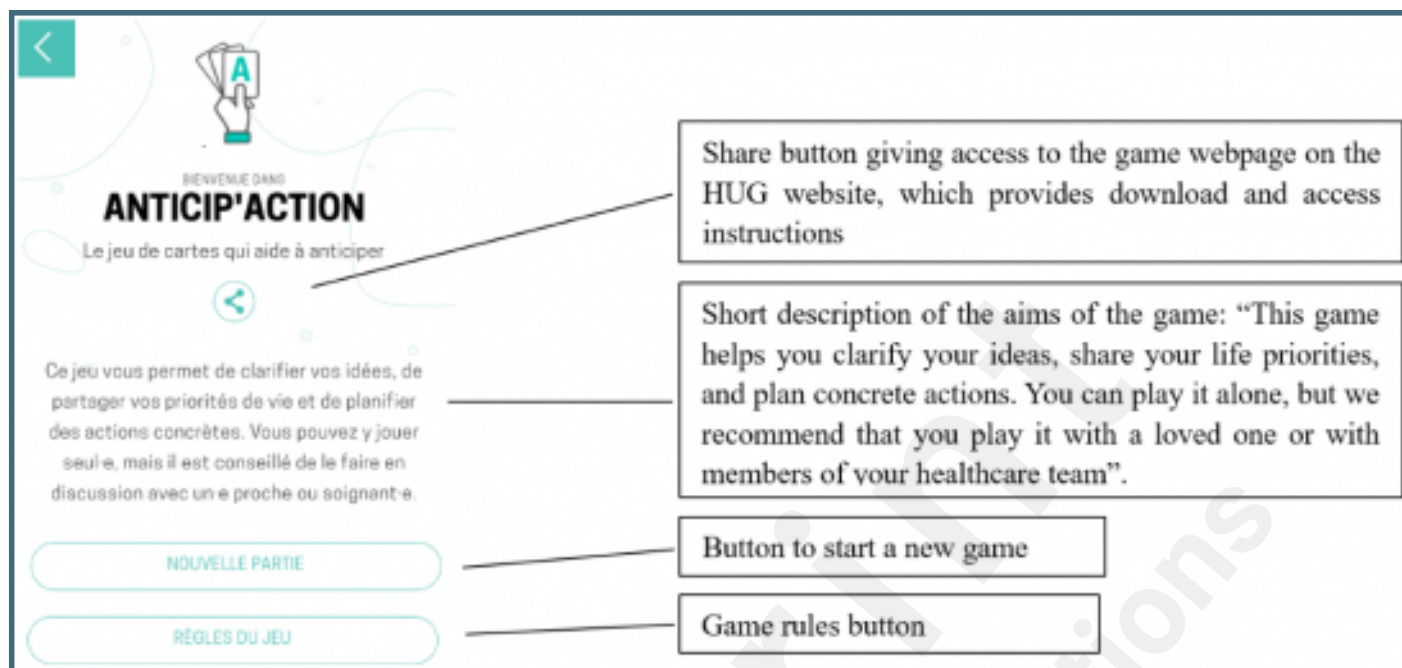
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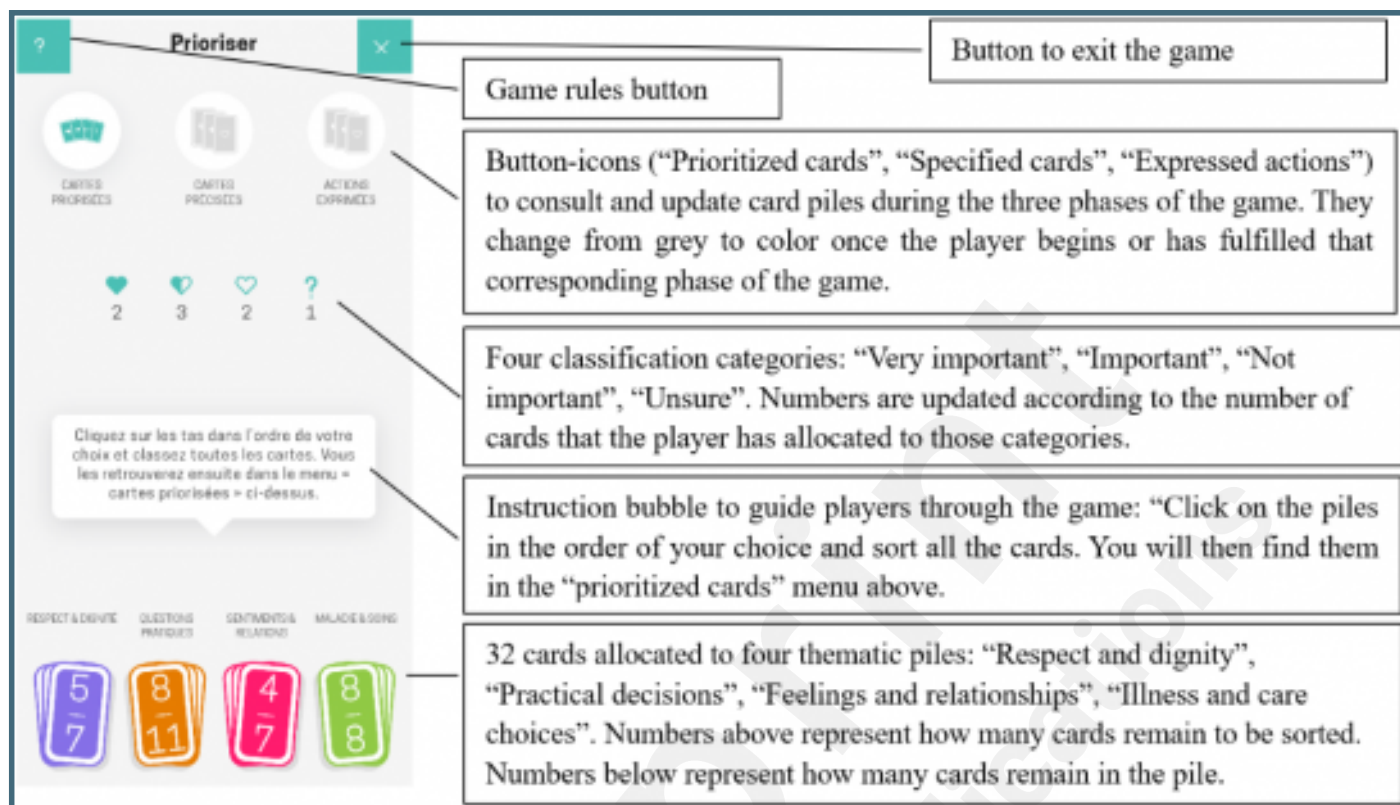
Supplementary Files

Figures

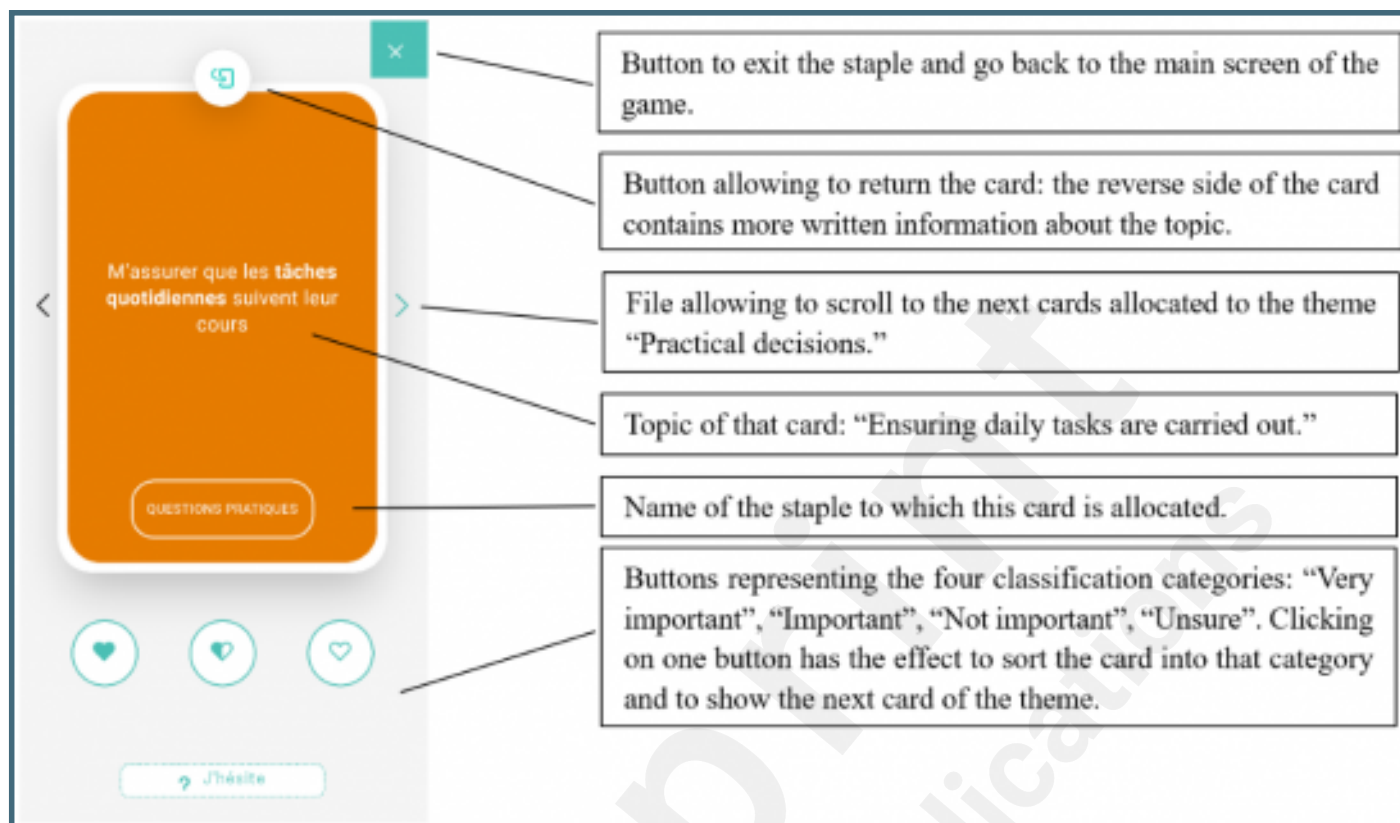
Welcome page of Anticip'action included in the Accordons-nous module.



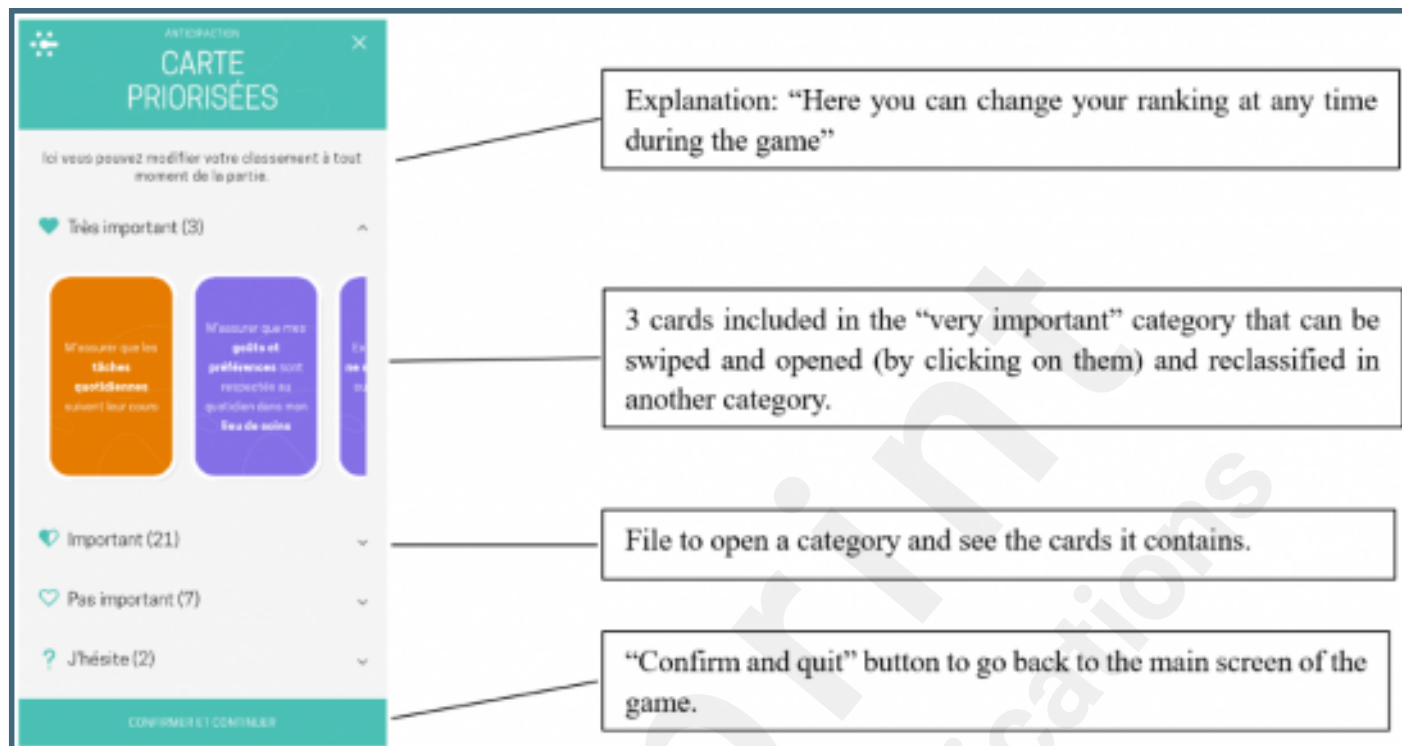
Main screen of the game.



Phase 1 – Prioritize: screen allowing to sort cards allocated to the theme “Practical decisions”.



“Prioritized cards” screen allowing to resort cards in different categories at any time of the game. It can be accessed from the main screen, by clicking on the “Cards Prioritized” button-icons (top left).



Phase 2 – Specify: screen allowing to specify reasons for having selected cards as “very important”.

M'assurer que les tâches quotidiennes suivent leur cours

Ecrivez ce qui vous importe

☐ C'est réglé.

☐ Je dois m'en occuper.

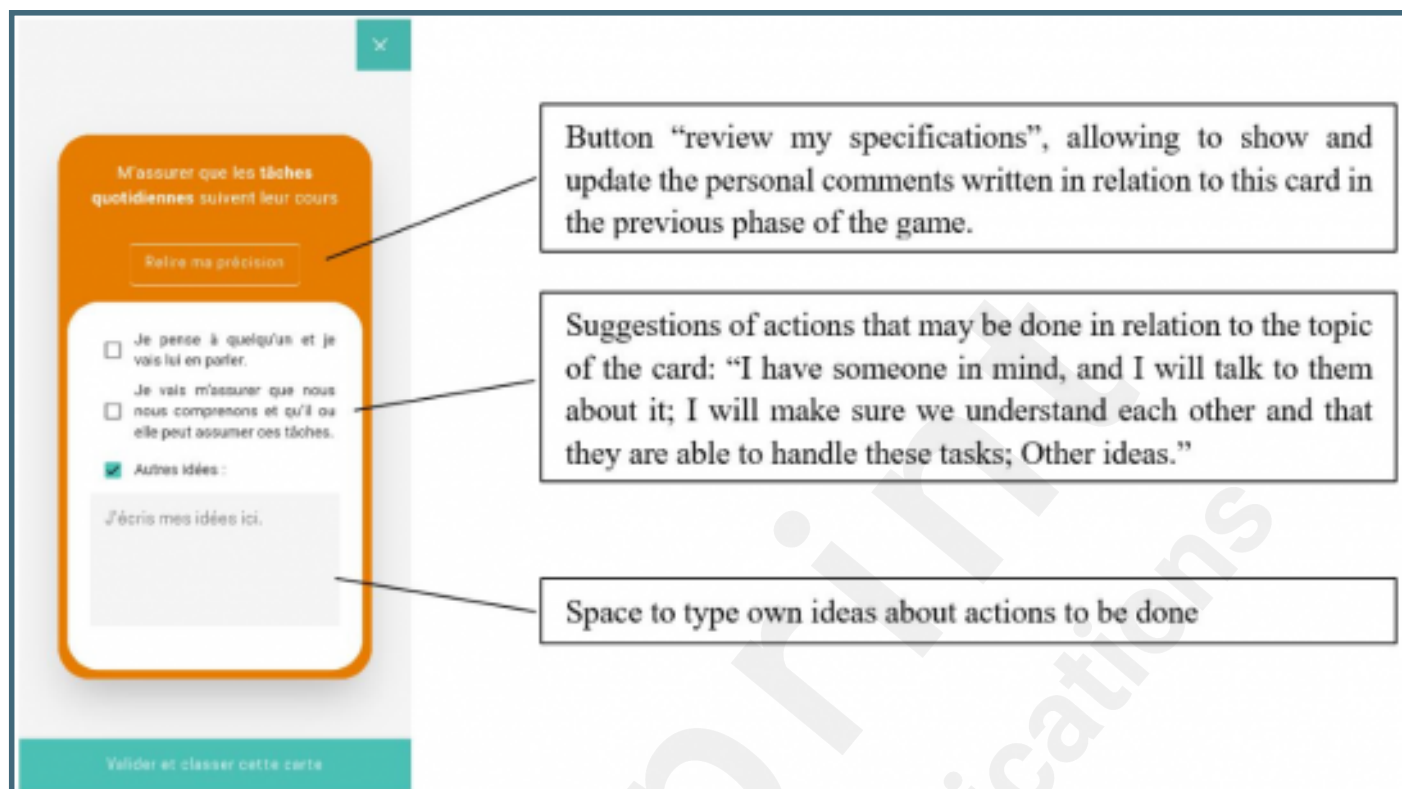
Valider et classer cette carte

Space to type own specification text related to the topic of the card.

Dichotomous options to specify whether an action has to be done in relation with this topic or whether everything is settled or under control. Cards for which something needs to be done are taken over to the final “action” phase of the game.

Button to validate specifications. It closes the card and show the next one.

Phase 3 – Act: screen allowing to choose actions to complete in relation with the topic of the card.

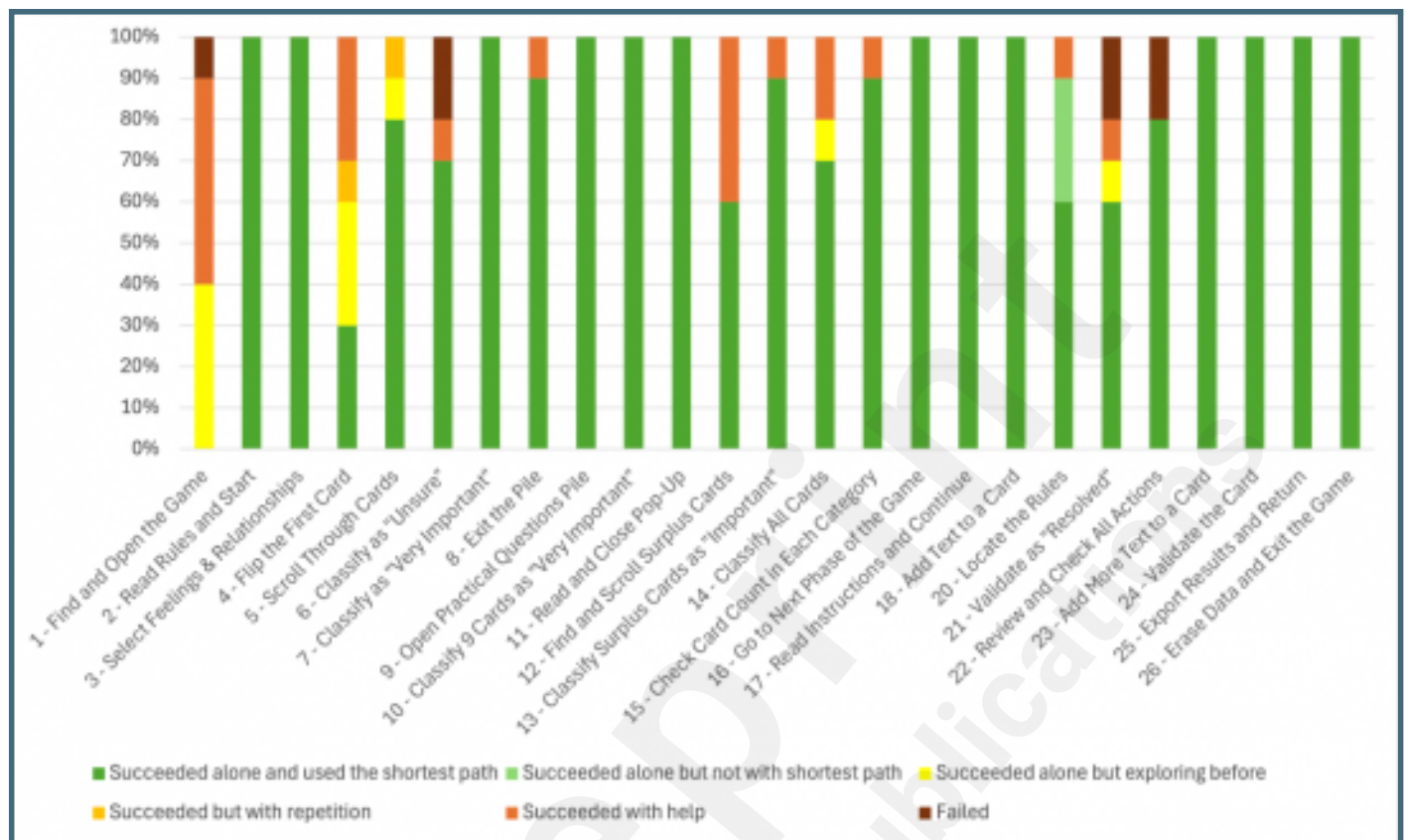


Button “review my specifications”, allowing to show and update the personal comments written in relation to this card in the previous phase of the game.

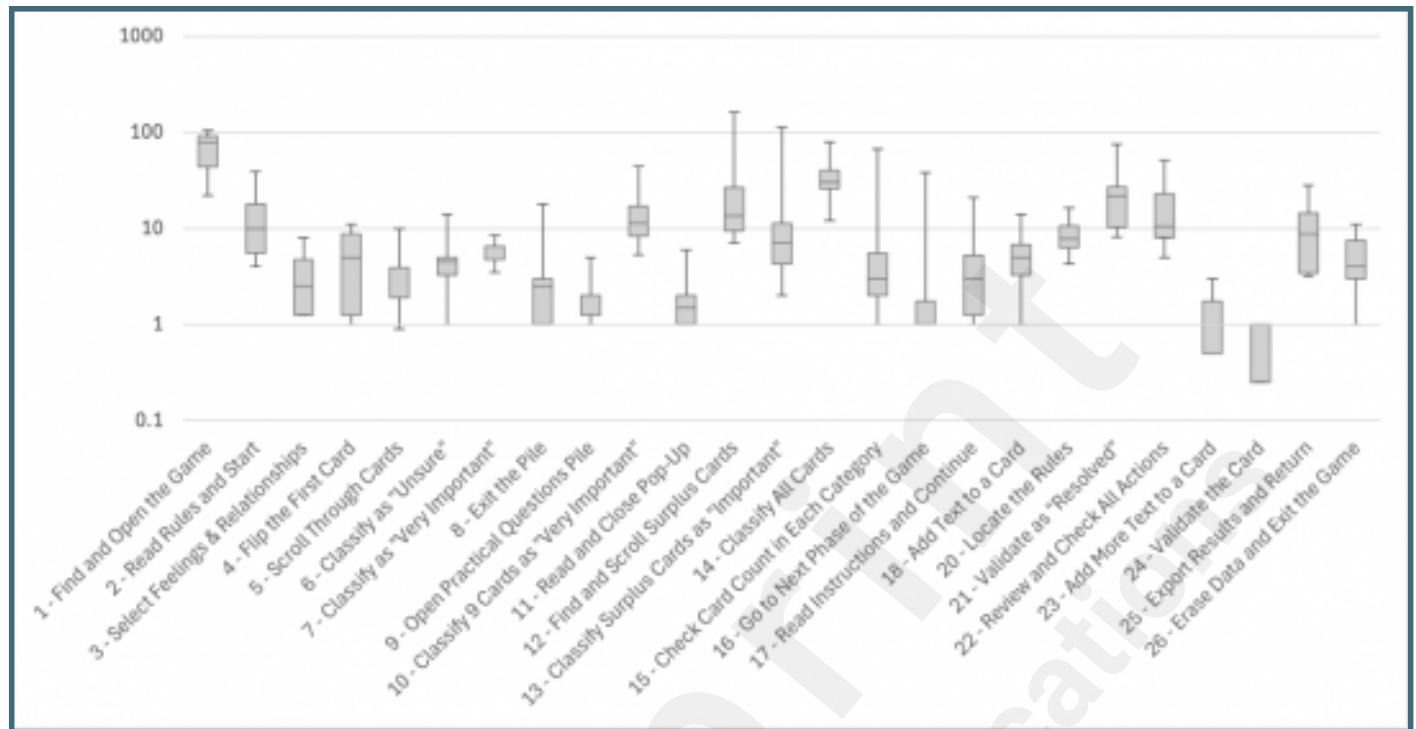
Suggestions of actions that may be done in relation to the topic of the card: “I have someone in mind, and I will talk to them about it; I will make sure we understand each other and that they are able to handle these tasks; Other ideas.”

Space to type own ideas about actions to be done

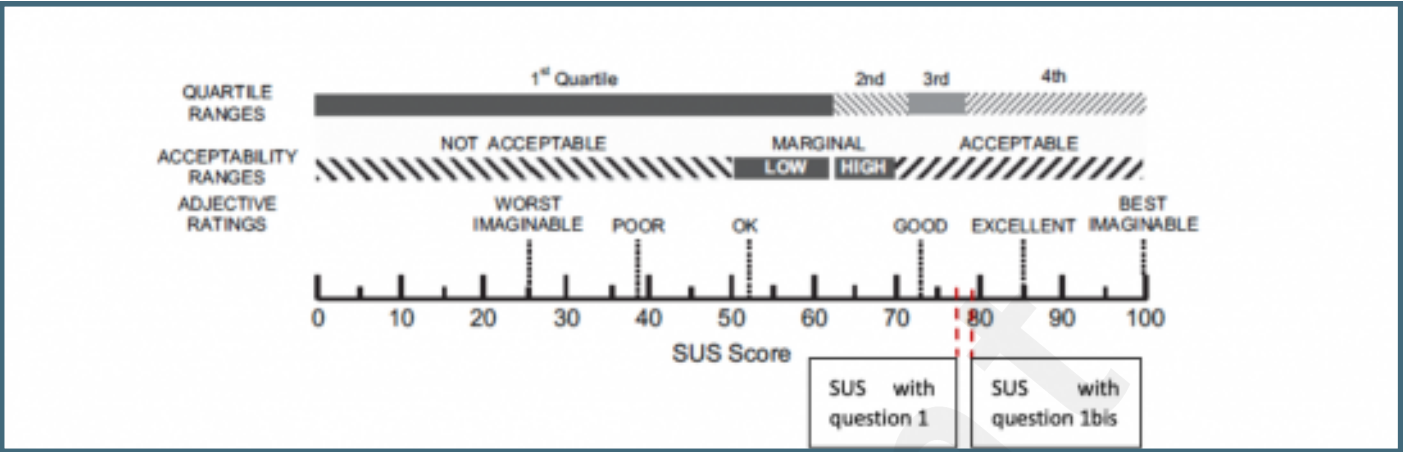
Proportion of participants who succeeded or failed to complete study tasks with or without input from the experimenter, the type of input and with or without using the shortest path during the think-aloud procedure.



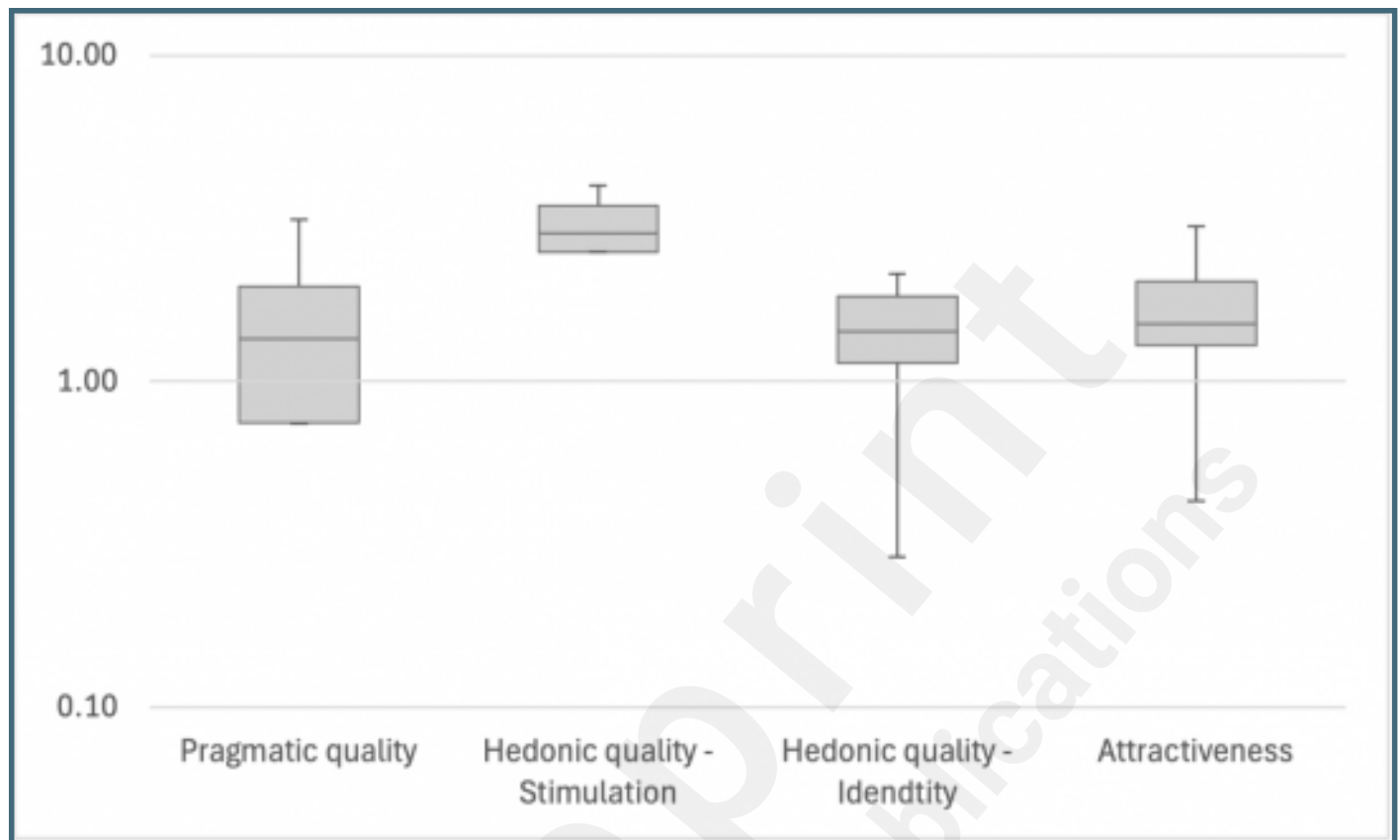
Mean time (in seconds) spent by participants for completing each of the 25 tasks during the think-aloud procedure, displayed on a logarithmic scale.



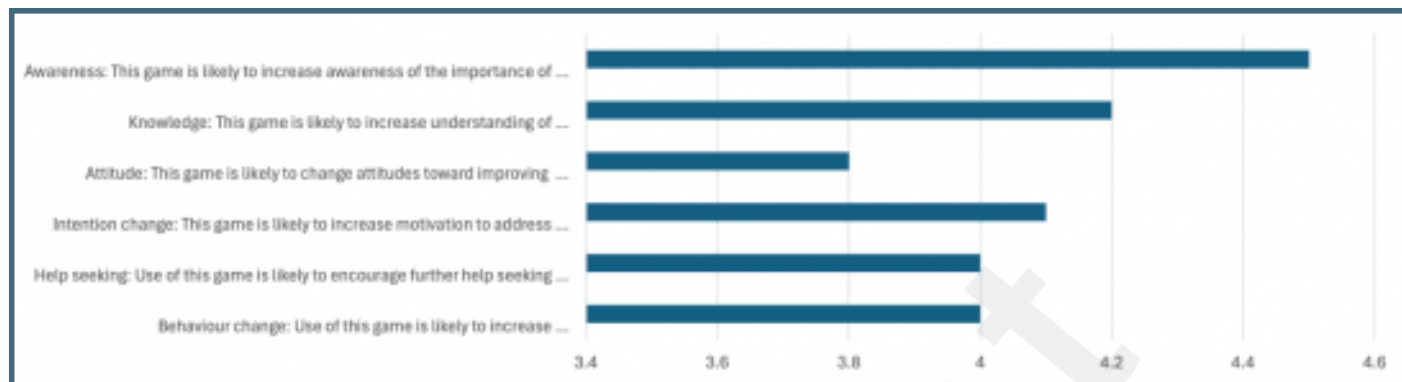
Score of the game Anticip’action on the original and updated versions of the System Usability Scale.



Mean scores of the game Anticip'action on the four dimensions of the AttrakDiff questionnaire, displayed on a logarithmic scale.



Average responses of participants to the 6 items of the MARS questionnaire. All questions ended with “[...] the anticipation of difficult situations that may arise in the future”.



Multimedia Appendixes

This supplementary file contains Table S1, questionnaires used, and discussion grid for the final qualitative feedback, in original language (French) and English translation.

URL: <http://asset.jmir.pub/assets/160015d8d675a662ec6055ba5ef1523b.docx>

