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Dissemination

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Developing and evaluating serious games and input techniques for people with moderate to severe dementia using heuristic evaluation

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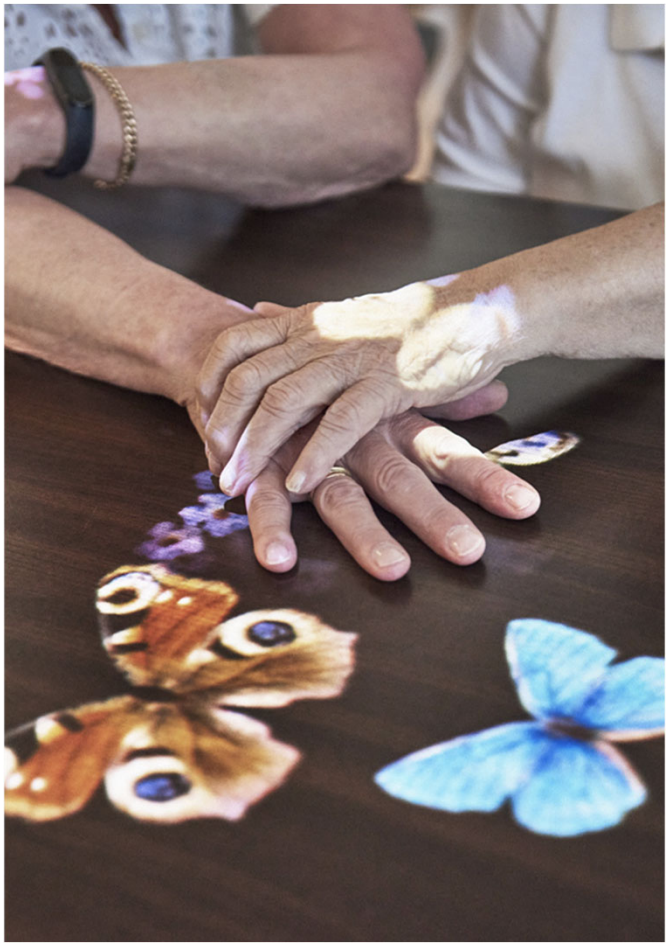
Introduction

- In 2018, Europe had nearly 9.8 million people living with dementia, a number projected to double to 18.8 million by 2050
- Over 70% of people living with dementia experience apathy
- Serious games can reduce apathy by causing physical activity, cognitive stimulation, sensory stimulation and social interaction
- Not everyone can use these systems



Georges, J., Miller, O., & Bintener, C. (2020). Estimating the prevalence of dementia in europe. *Report N.*
Cipriani, G., Lucetti, C., Danti, S., & Nuti, A. (2014). Apathy and dementia. nosology, assessment and management. *Journal of Nervous & Mental Disease*
Anderiesen, H. (2017). *Playful design for activation* (Doctoral dissertation). Delft University of Technology.
Image: Tover

Tovertafel Pixie, Image: Tover

Introduction

- Mobile projection-based games systems can be used to make it more accessible, like the Tovertafel Pixie
- However, when used in a resident's room, it's primarily used passively
- Table projections are difficult in bed, Wall projections provide difficult interaction
- Serious games using different interaction methods could help make this system even more accessible (e.g. voice commands)

Problem Statement

- Prototypes of serious games using new interaction techniques need to be tested

- User tests are more difficult to perform:
  - Consent
  - Ethical constraints
  - (Usually) can't retrieve player opinions
  - Covid-19 precautions

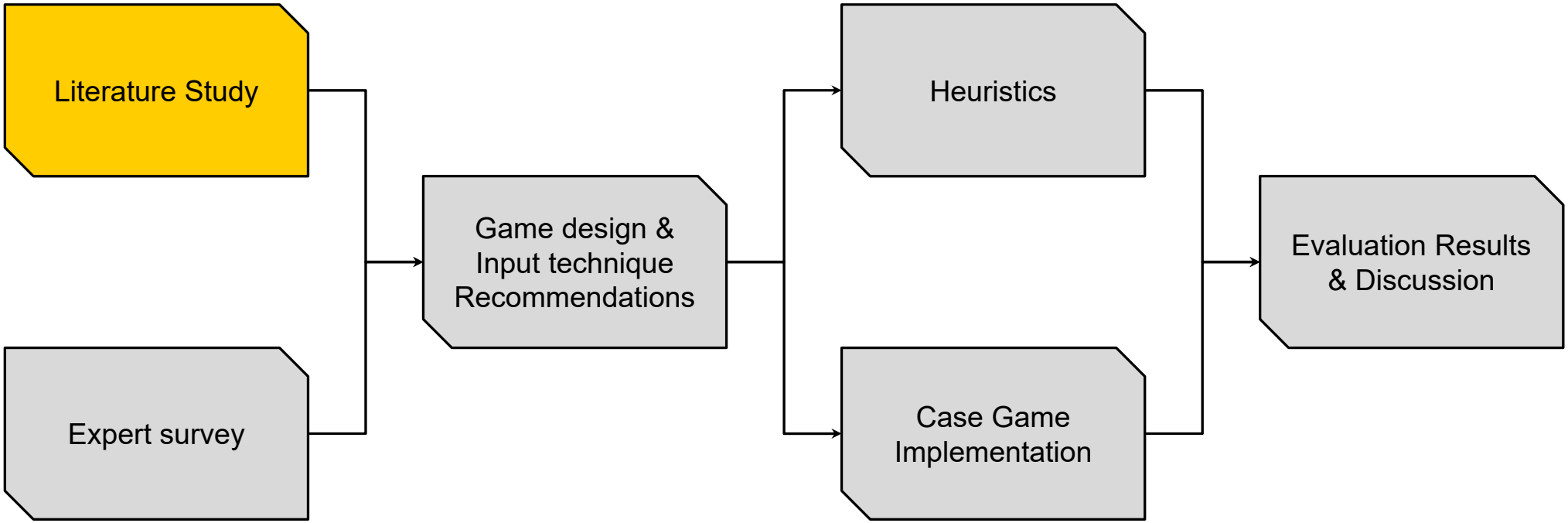
- Ideally, the games would be tested without involving the target audience

Potential solution: **Heuristic Evaluations**

- Perform tests with experts instead of users
- Usually used for usability tests to quickly find issues within a system
- Method falls short for serious games for people with dementia, new heuristics need to be defined
- Could be performed with other experts, professional care-providers of people with dementia

Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*

Study overview



Literature study

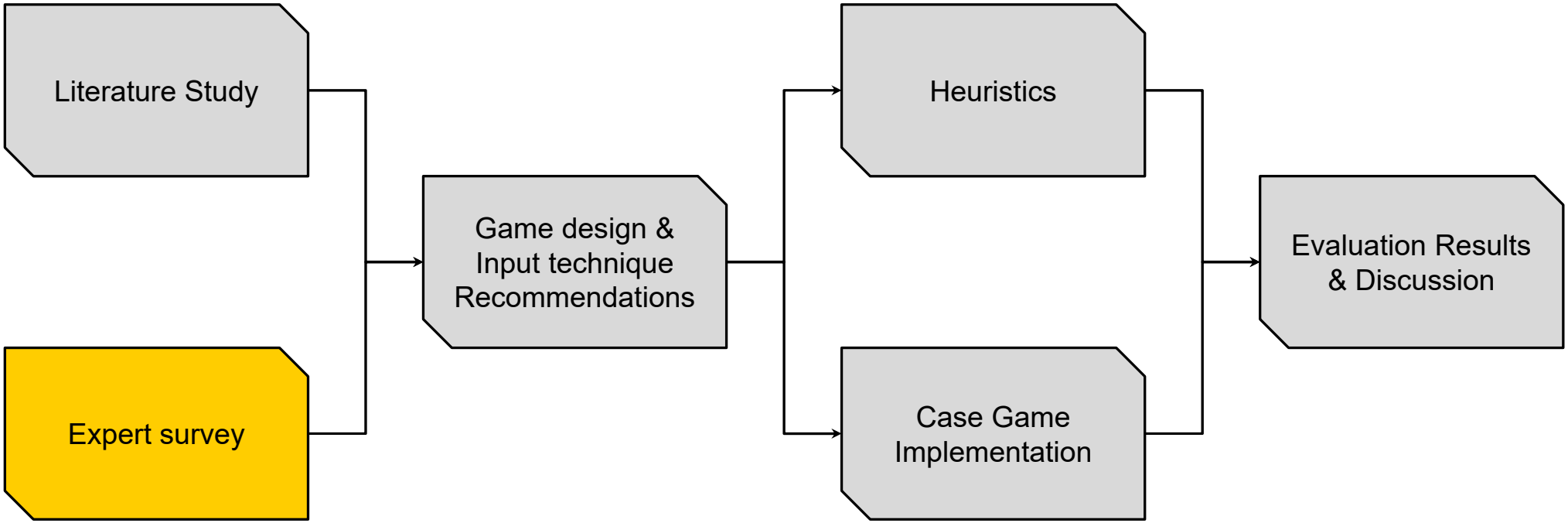
- Finding recommendations for designing games and input techniques for people with dementia

- Four different areas:
  - Dementia and play experiences
  - Apathy
  - Serious games for people with dementia
  - Input techniques

- Resulted in twelve recommendations found in literature

Image: Vallejo, V., Tarnanas, I., Yamaguchi, T., Tsukagoshi, T., Yasuda, R., Müri, R., Mosimann, U. P., & Nef, T. (2016). Usability assessment of natural user interfaces during serious games: Adjustments for dementia intervention. *J Pain Management*

Study overview



Expert survey

- At Tover, experts applied some design principles that were not found in literature
- A questionnaire was made to gather information
- Four Tover experts provided recommendations for designing games for people with dementia

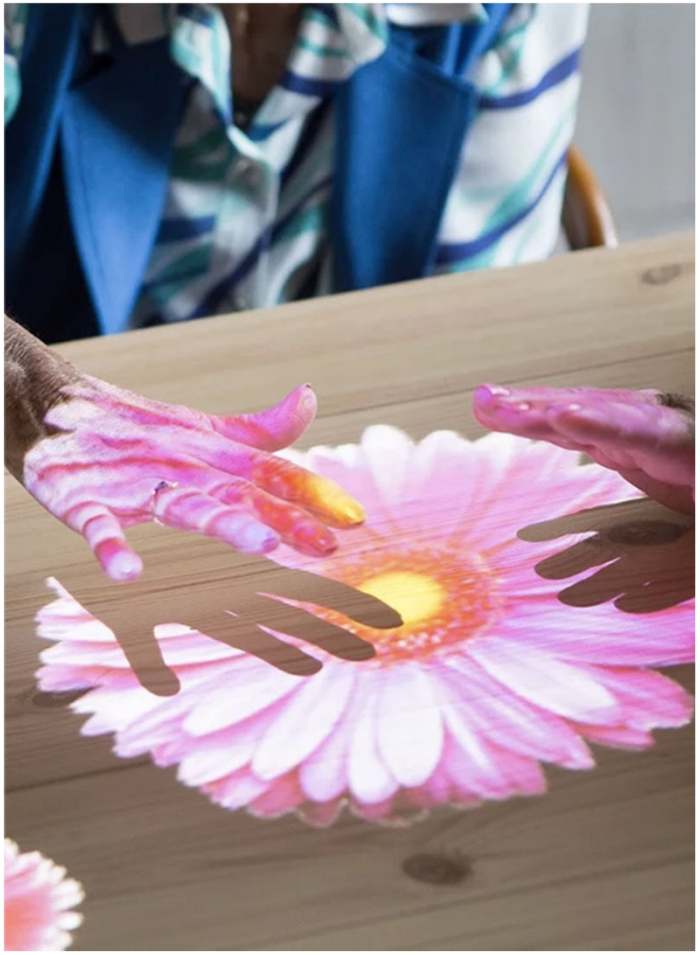
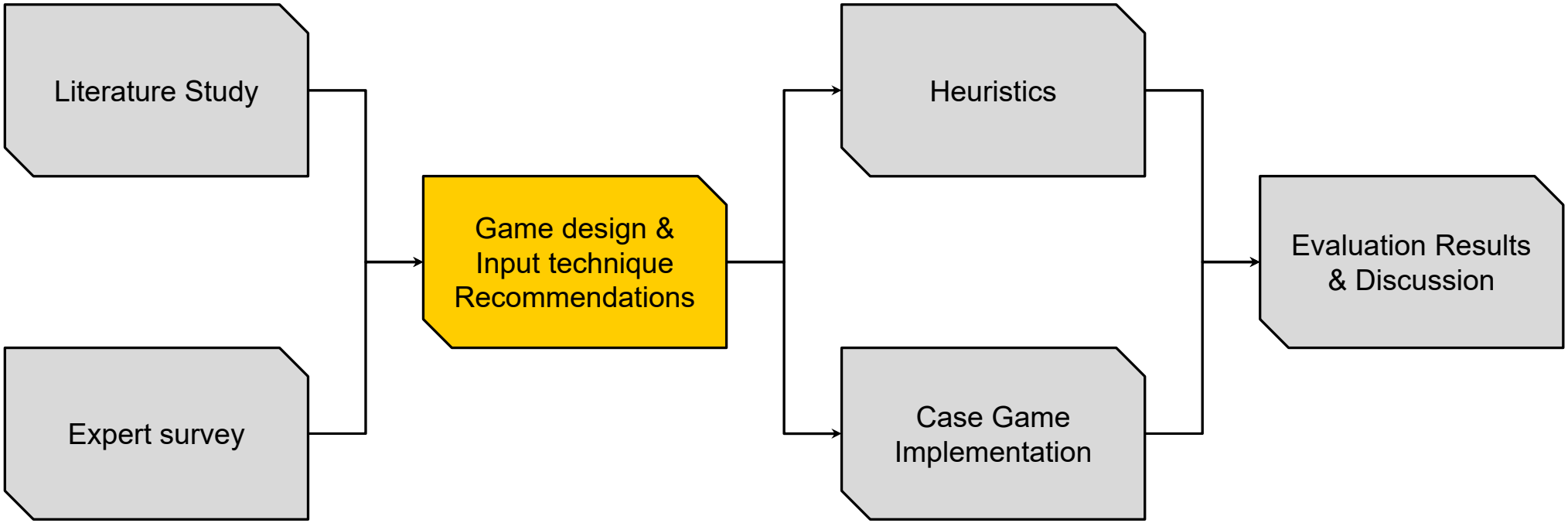


Image: Tover

Study overview



	Recommendations	Reference(s)
1	Take into consideration the stage of cognitive and physical decline.	(Anderiesen et al., 2015; Robert et al., 2014)
2	Balance the game's challenges with the user's ability to address and overcome them.	(Bouchard et al., 2012; Chen, 2007; Robert et al., 2014)
3	Should incentivise physical activity, cognitive stimulation, sensory stimulation, and social interaction	(Anderiesen, 2017)
4	Relaxation, reminiscence and sensation are the most applicable play experiences for people in late stages of AD.	(Anderiesen et al., 2015)
5	Take into account the social and cultural background of the user, especially when implementing a reminiscence play experience.	(Anderiesen et al., 2015; Robert et al., 2014)
6	Create good luminosity using warm, bright colors and clearly defined contrast.	(Bouchard et al., 2012)
7	Use different types of prompts (e.g. visual, audio) when providing assistance.	(Anderiesen, 2017; Bouchard et al., 2012)
8	Should offer structured occupational activity for (even) short periods of time	(Ferrero-Arias et al., 2011)
9	Make sure the input technique feels familiar to the user.	(Robert et al., 2014; Salvendy et al., 1997)
10	The input technique must match the task to be performed in order to feel natural.	(Vallejo et al., 2016)
11	Make sure the input technique does not require very small and precise movements.	(Robert et al., 2014; Vallejo et al., 2016)
12	Target people in mid to late stages of dementia because that is where the physical deterioration is prevalent and they show more signs of apathy.	(Anderiesen, 2017; Ferrero-Arias et al., 2011; Landes et al., 2005; Reisberg et al., 1982)
13	Avoid a feeling of making mistakes in the game, ensure the game focuses on what people are able to do instead.	Expert survey
14	Aim to keep players actively engaged by using active cues to recapture the player's attention when lost.	Expert survey
15	While creating the game, involve people with dementia in the design process by testing together with them.	Expert survey

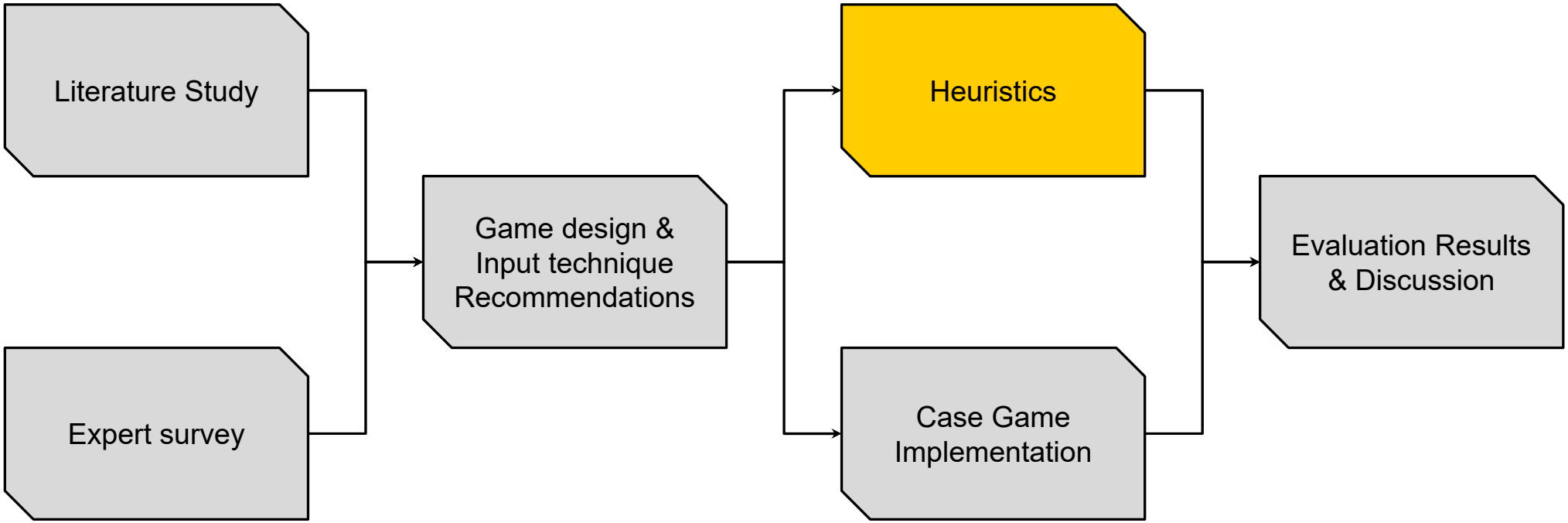
Table 1: Recommendations for designing serious games and input techniques for people with dementia, gathered from literary study and expert survey.

Combined list of recommendations

From literature study

From expert survey

Study overview



Heuristics

- Rules of thumb, quick guidelines based on experience
- Formulated based on recommendations, refined together with experts from Tover

H2: The game should give incentives for physical activity, cognitive stimulation, or social interaction

- *Does the game encourage physical movement or activity during gameplay?*
- *Are there challenges or activities in the game that give cognitive stimulation?*
- *Does the game promote social interaction while playing?*

H1: The game should consider cognitive decline

H2: The game should give incentives for physical activity, cognitive stimulation, or social interaction

H3: The game should provide emotional engagement and avoid negative feelings

H4: The game should stimulate engagement and re-engagement

H5: The game should have a user-friendly input technique with task alignment

H6: The game should consider visual and auditory impairment

H7: The game should mind cultural and social backgrounds

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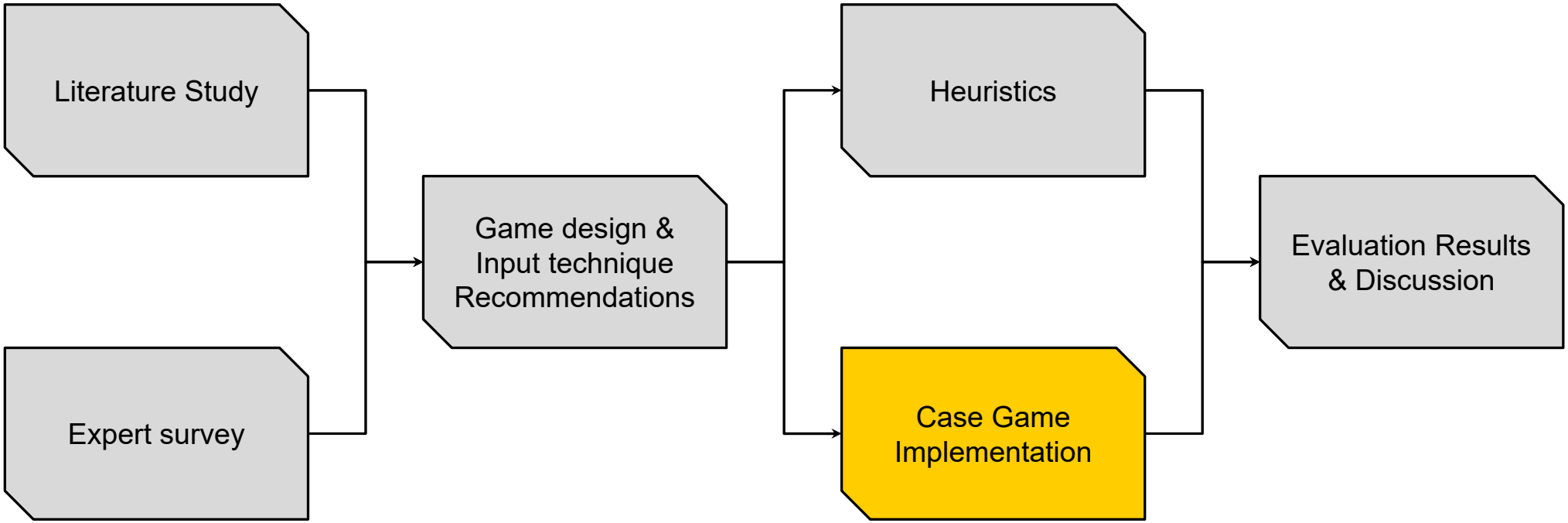

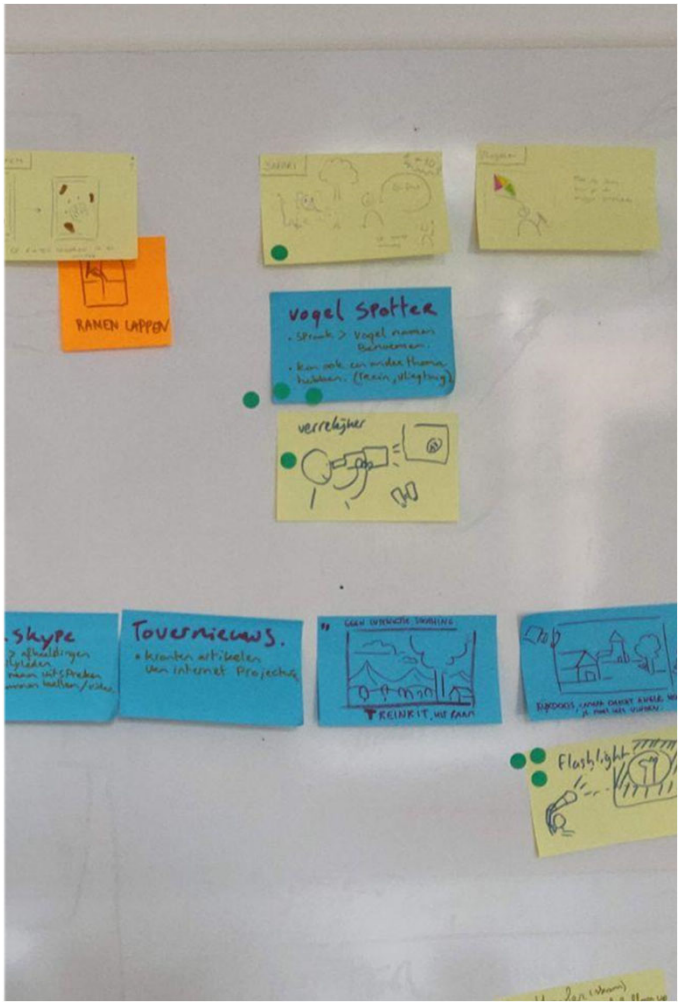

Case game design

- Serious game that is accessible designed for people with moderate to severe dementia (scale 5-7 on the Global Deterioration Scale)
- Designed to be used with Tovertafel Pixie
- Brainstorm with experts at Tover
- Ideas selected based on list of recommendations

Reisberg, B., Ferris, S. H., de Leon, M. J., & Crook, T. (1982). The global deterioration scale for assessment of primary degenerative dementia. *American Journal of Psychiatry*

Case game design

- Orchestra conductor game
- Input technique: Camera based tracking or accelerometer and gyroscope based tracking?
- Musical focus could cause feelings of reminiscence

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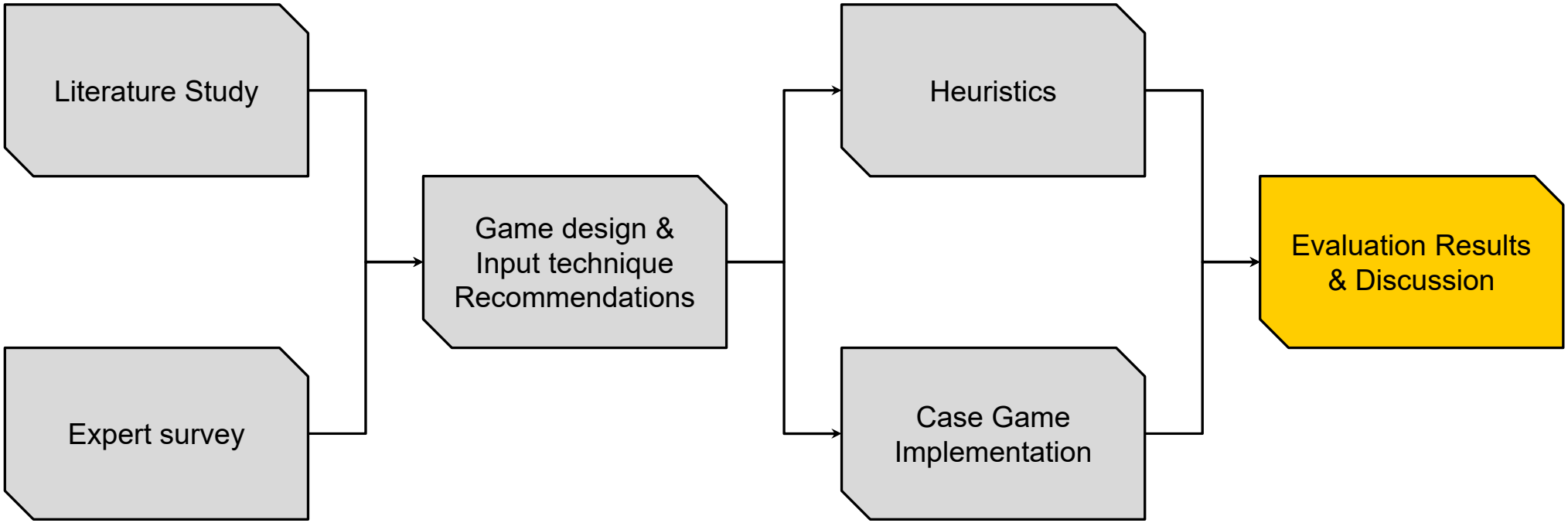
Study overview



Heuristic Evaluation Results

- 8 participants, professional care-providers of people with dementia
- 4 different nursing homes in the Netherlands
- Questions from the 7 heuristics, free-form evaluation
- Results gathered through audio recording

Discussion and Limitations

- Eight suggestions to improve the game:
  - Enhance sensor responsiveness
  - Better customization for sensor sensitivity
  - Introductory phase
  - More cues to get the player re-engaged
  - Brighter colors and more visual variety
  - Using non-sensor sticks for collaborative play
  - Provide clear instructions for achieving tempo
  - Personalised music selection

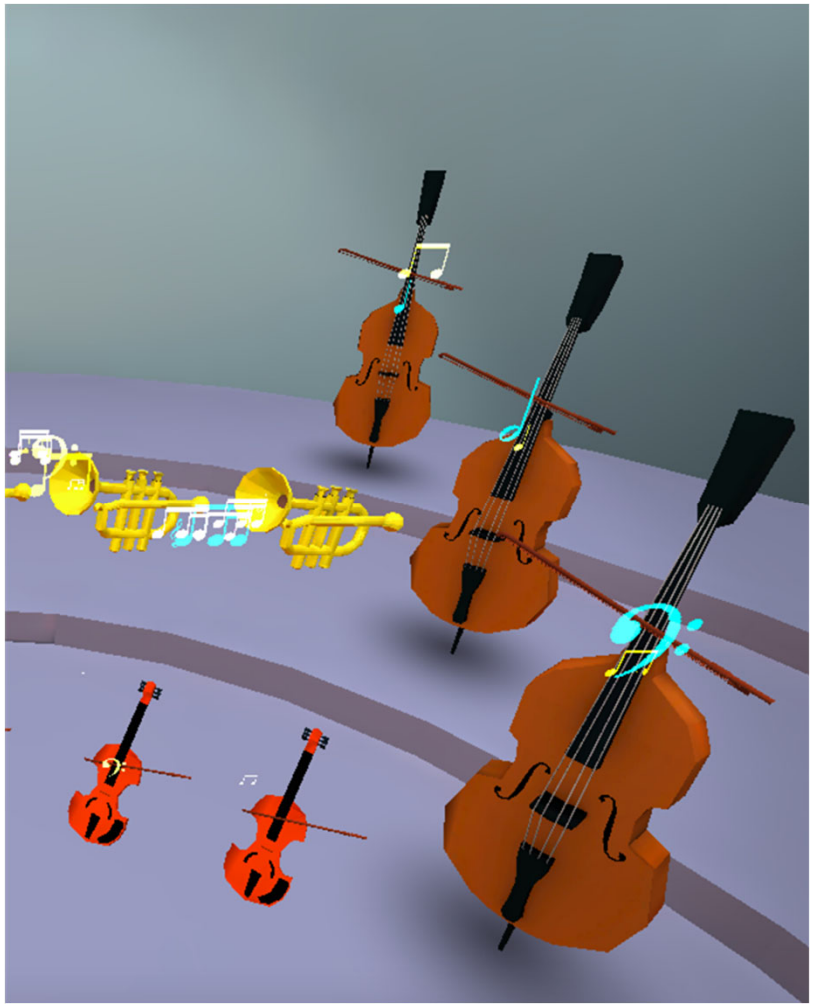
- The game stimulates physical activity, cognitive stimulation, and social interaction

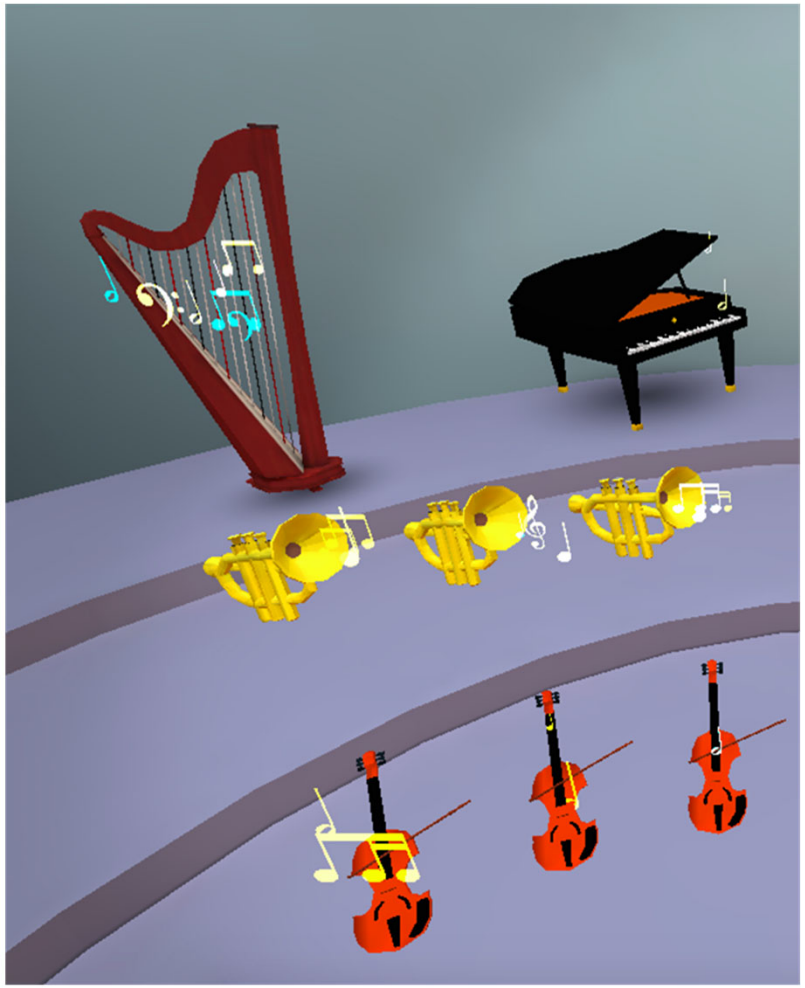
- Limitation: Sensor responsiveness was suboptimal during evaluations

- Ordering of heuristics could be improved

Conclusion

- The heuristic evaluation method can be used to provide a clear list of improvements for serious games for people with dementia
- The heuristic evaluations show that this game can be used to help against apathy





Future work

- Validation of heuristic evaluation by comparing with user study
- Ordering of heuristic evaluation questions
- Implement suggestions to case game
- Investigate effectiveness of multiplayer game with no-sensor batons

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