Feasibility and Acceptability of a New Web-based Cognitive Training Platform for Older Adults: the Breakfast Task

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Research

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Feasibility and Acceptability of a New Web-based Cognitive Training Platform for Older Adults: the Breakfast Task

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Abstract

Background: Developing efficient cognitive training for the older population is a major public health goal due to its potential cognitive benefits. A promising training target is executive control, critical for multitasking in everyday life. The aim of this pilot study was to establish the feasibility and acceptability of the Breakfast Task training in older adults, a new web-based cognitive training platform that simulates real-life multitasking demands.

Methods: A community-based sample of 24 cognitively healthy participants aged between 60 and 75 (*M* = 69.12, *SD* = 3.83) underwent 5-session cognitive training protocol, delivered online. Each session lasted 45 minutes and occurred twice a week at participant's homes. Performance was recorded, and participants completed questionnaires at baseline and after the intervention.

Results: Feasibility metrics showed overall high recruitment (82.7%), adherence and retention rates (100%). Acceptability was considered good based on participant`s quantitative and qualitative responses. On average, participants rated the game as interesting, enjoyable and did not report difficulties in accessing the game online without supervision or in understanding the instructions. Participants showed a learning curve across sessions, suggesting improvement in the game outcomes and potential benefits from the emphasis change training approach. The study identified relevant areas that need improvements and adjustments, such as technical issues, session's structure and dose.

Conclusions: The findings provide preliminary support for the feasibility and acceptability of the Breakfast Task training platform in cognitively healthy older adults, with promising potential cognitive benefits. Results suggest the value of further research investigating the Breakfast Task training features and dose-response relationship, as well as its potential efficacy in older adults via larger randomized controlled trials.

Trial Registration: *ClinicalTrials.gov: NCT04195230 (Registered 11 December 2019). https://clinicaltrials.gov/ct2/show/NCT04195230*

Keywords: Clinical Trial Methods, Digital intervention, Healthy/Active Aging, Cognition, Multitasking.

Key messages regarding feasibility

- Acceptability is good but not great, technical issues and dose still need to be improved
- Good recruitment rate (82.7%), great adherence and retention (100%) in a short training regimen and presence of learning curve across sessions
- The use of the Breakfast Task training platform for future behavioral/cognitive trials

Background

Maintaining a cognitively active lifestyle has been associated with better cognitive function and reduced dementia risk in late-life (Edwards et al., 2017; Gavelin, Lampit, Hallock, Sabates, & Bahar-Fuchs, 2020; Hertzog, Kramer, Wilson, & Lindenberger, 2009; Ngandu et al., 2015; Rebok et al., 2014; Sommerlad et al., 2020; Verghese et al., 2003). Therefore, a major public health goal is developing effective cognitive interventions to enhance and/or maintain cognitive health in older adults, which may attenuate age-related cognitive decline and contribute to functional independency, quality of life, and dementia prevention.

A critical intervention approach for older adults is cognitive training, or the repeated practice of standardized exercises targeting specific cognitive processes that may optimize cognitive functioning in everyday life (Gavelin et al., 2020; Simon et al., 2020). In older adults, cognitive training has been associated with short-term cognitive improvements and near-transfer effects (Anguera et al., 2013; Ball et al., 2002; Basak, Qin, & O'Connell, 2020; Borella, Carretti, Riboldi, & De Beni, 2010; Brehmer, Westerberg, & Backman, 2012; Dahlin, Neely, Larsson, Backman, & Nyberg, 2008; Lampit, Hallock, & Valenzuela, 2014; Ngandu et al., 2015; Sala et al., 2019; Simon et al., 2018; Simons et al., 2016; Willis et al.,

2006), as well as some long-term benefits, such as reduction of cognitive/functional decline (Anguera et al., 2021; Rebok et al., 2014) and dementia risk (Edwards et al., 2017), although more evidence is needed for definitive conclusion. It is hypothesized that cognitive training in older adults may induce brain processes that protect individuals from the effects of aging and brain diseases, possibly by increasing cognitive reserve later in life (Stern, 2013; Stern et al., 2020).

Technology has been increasingly integrated to cognitive training and is an opportunity to improve intervention design, engagement, and accessibility to cognitive intervention. Different reviews indicate that computerized cognitive training is feasible in cognitively heathy older adults (Basak et al., 2020; Lampit et al., 2014; Sala et al., 2019; Simons et al., 2016), and there is evidence that the same cognitive training protocol can show similar effects when delivered remotely (online) or face-to-face (Rebok, Tzuang, & Parisi, 2020). One of the main challenges is the limited transfer effects, which typically occurs to proximal outcomes, but not to distal outcomes (i.e., far-transfer or context transfer) (Basak et al., 2020; Owen et al., 2010; Sala et al., 2019; Simons et al., 2016). The limited transfer effects suggest the need of training protocols that are more meaningful and related to everyday life demands, which can facilitate transfer to distal outcomes. In addition, there is evidence that unsupervised online cognitive training is less effective than supervised intervention (Lampit et al., 2014), a critical ingredient to consider when delivering online interventions. Another challenge when delivering computerized cognitive training online is adherence, not always easy to predict, but it seems to be facilitated through intervention reminder system (Harrell, Roque, Boot, & Charness, 2021) and a

promising approach is hybrid supervision design, where sessions are partially supervised remotely.

A relevant target for cognitive training is executive control, which is known to decline with aging and is critical for multi-tasking in everyday life (Anguera et al., 2013; Bialystok, 2006; Bier, de Boysson, & Belleville, 2014; Verhaeghen, Steitz, Sliwinski, & Cerella, 2003) (e.g., talking while driving, cooking a meal for guests). Despite the challenge demonstrating training-transfer effects in older adults, executive control training has shown encouraging findings. For instance, executive control training programs (Anguera et al., 2013; Bherer et al., 2005, 2008; Bier et al., 2014; Blumen, Gopher, Steinerman, & Stern, 2010; Gopher, 2007; Gopher, Weil, & Bareket, 1994; Mackay-Brandt, 2011; Stern et al., 2011; Zendel, de Boysson, Mellah, Demonet, & Belleville, 2016) have shown improvements in performance on the trained tasks and “near”/content transfer effects, reflecting transfer of gains from trained tasks to untrained tasks of similar nature or content (Barnett & Ceci, 2002). However, the extent to which transfer occurs to a different or more distal context (far or context-transfer), such as everyday life situations, remains unclear (Basak et al., 2020; Owen et al., 2010; Sala et al., 2019; Simons et al., 2016).

A promising executive control / multitasking training approach is emphasis change (EmCh), a method that requires participants to systematically change their emphasis / attention allocation policy between subcomponents of a task, enhancing exploration of solution strategies and cognitive flexibility (Gopher, 2007). EmCh has demonstrated context-transfer from a complex video game to actual flight performance in young pilots (Gopher et al., 1994). The same protocol enhanced executive functions in older adults; however, the motor requirements of the task limited the results in a subset of participants

157 (Blumen et al., 2010; Stern et al., 2011). A similar training method, Variable Priority, has
158 endorsed the EmCh findings by showing that multi-tasking performance is optimized when
159 attention is prioritized towards one task over the other, i.e., when emphasis change
160 instructions are utilized (Bier, Ouellet, & Belleville, 2018; Kramer, Hahn, & Gopher, 1999;
161 Lussier, Bugaiska, & Bherer, 2017). These training methods are considered particularly
162 powerful for inducing transfer of training in older adults (Bier et al., 2014). Variable Priority
163 studies have found age-equivalent content-transfer effects among young and older adults
164 (Bherer et al., 2008; Lussier et al., 2017), and even larger transfer effects in older adults
165 (Bier et al., 2018), in contrast to other training approaches with limited transfer in older
166 population (Dahlin et al., 2008; Derwinger, Neely, Persson, Hill, & Bäckman, 2003).

167 To date, the EmCh approach has not been applied to ecological tasks, which
168 simulate daily life situations, which would enhance its clinical and real-life relevance.
169 Moreover, EmCh has not been implemented remotely, which may enhance its accessibility
170 to a diverse population (e.g., individuals with mobility difficulties, living in remote regions,
171 and across education backgrounds, genders, and race/ethnicities) and adaptability to
172 different life demands. Strategies to keep older adults cognitively active at home are
173 additionally relevant due to the COVID-19 pandemic, which limits in-person social
174 interaction and research participation.

175 The aim of this pilot study is to establish the feasibility and acceptability of a new
176 web-based cognitive training platform, the Breakfast Task, among cognitively healthy older
177 adults. We hypothesized that older adults would be able to engage and use the training
178 platform without supervision, consider it acceptable, and show some responsiveness to the
179 EmCh approach.

Methods

Study design

The overall study design is illustrated in Figure 1 and includes a brief pre-intervention screening, five sessions, and post-intervention questionnaire. This single-arm online interventional study occurred during the COVID-19 pandemic, from January to July 2021. It is worth mentioning that this study was originally conceptualized to occur in-person and was initiated at the end of 2019. However, due to the pandemic, the study was interrupted in March 2020, the methods adjusted to be remote/online, and the study was re-initiated in 2021. The limitation of in-person interactions imposed by the pandemic was an opportunity to integrate telehealth to the project and collect data online as participants participated in the study from their homes. The CONSORT 2010 guideline for pilot and feasibility trials (Eldridge et al., 2016) was used to report the findings of this study. Items that were not applicable such as randomization and blinding were omitted as there was no control group.

[Figure 1]

Registration, ethics approval and online consent

The trial was registered on the *ClinicalTrials*.gov registry (ID: NCT04195230). The study protocol and documents were reviewed and approved by the Internal Review Board of the College of Physicians and Surgeons of Columbia University (reference: IRB-

202 AAAS6529). Online written informed consent to participate was obtained from each
203 participant through a secure electronic signature system.
204
205 ***Recruitment and eligibility***
206 Participants living in the New York City area were recruited from the community via
207 flyers, emails to NGOs focused on aging populations, referrals from colleagues and
208 research subjects, and Columbia University's online recruitment platform (*RecruitMe*),
209 which connects university researchers to potential participants. It is worth mentioning that
210 initially this was an in-person study, and part of the sample were contacted before the
211 COVID-19 pandemic (October-December 2019). However, due to the pandemic, we
212 adapted the study to be online and in February 2021 we re-initiated the study e re-
213 contacted the participants.
214 Although formal sample size calculation may not be appropriate for pilot studies
215 (Julious, 2005); due to the online and remote nature of this intervention, and potential loss
216 of participants, we recruited more participants than the usual rule of thumb for pilot studies
217 (12 per group) (Julious, 2005) and the typical group size in cognitive training studies
218 (Lampit et al., 2014).
219 At pre-training, participants underwent a telephone screening to collect data about
220 demographics and medical history along with a brief remote cognitive and functional
221 screening (on Zoom). To be included in the study, participants had to meet the following
222 eligibility criteria: age between 60 and 75 years; have the capacity to speak and read in
223 English; preserved or corrected vision and hearing; preserved cognitive performance on
224 the remote Montreal Cognitive Assessment (MoCA) (score ≥ 26) (Chapman et al., 2019;

225 Iiboshi et al., 2020; Nasreddine et al., 2005) and on the Activities of Daily Living-Extended
226 (ADL-x) scale (Fieo et al., 2018). In addition, participants had to be able to navigate on
227 internet, use a computer (desktop or laptop) and a mouse. Smartphones and tablets were
228 not allowed, due to screen size. In the case participants had difficulty using the Zoom or
229 did not have access to a computer/internet, the study team provided Zoom tutorial/practice
230 and equipment with internet. Participants were excluded if they present any major
231 neurological or psychiatric conditions or use of medication considered to affect cognition.
232 Subject flow is shown in Figure 1 according to the CONSORT diagram for feasibility and
233 pilot clinical trials (Eldridge et al., 2016).
234
235 ***Intervention***
236
237 *Breakfast Task Training platform: development and translation*
238 The Breakfast Task (BT) training is a new computerized game platform designed by
239 Gopher et al., (2020) based on the Breakfast Task, a well-established computer-based
240 task developed to evaluate executive control in older adults (Craik & Bialystok, 2006). In
241 2020, during the COVID-19 pandemic, the BT was adapted to a web-based format,
242 enabling access from participant's homes. In brief, the BT simulates a life situation that
243 demands executive control, attention management, and multi-tasking. It includes two
244 simultaneous tasks: the Table Setting task, in which participants have to set tables for
245 guests, and the Cooking task, in which participants have to cook foods with different
246 cooking time requirements (Figure 2). Some advantages of the BT platform are that is 1)
247 training can be designed under different difficulty levels and instructions, 2) flexibility

regarding duration and number of trials or sessions, 3) automatized scoring system that is already programmed to be saved in the online platform, and 4) is internet-based, so it can be administered remotely.

[Figure 2]

The BT instructions were first created in Hebrew at the Technion Institute of Technology, then translated to American English in collaboration with Columbia University, in three steps. First, two English-Hebrew speaking people produced an independent translation from Hebrew to English. Second, these versions were unified to reach a consensus on the English version under the supervision of two neuropsychologists trained in the aging field. Third, to ensure the accuracy of the translation, the training instructions were translated back from English to Hebrew by a neuroscience student proficient in both languages.

Game Tasks: Table Setting and Cooking

During the game, participants were instructed to “prepare breakfast”, so they set tables for guests while concurrently cooking foods for breakfast. The game goals were to: 1) set as many tables as possible, 2) cook each food item in its accurate time (i.e., not over- or under-cooking), and 3) finish cooking all food items at the same time so they could be served together. Scoring measures combined performance on the Table Setting and Cooking tasks, and the overall goal was to achieve a better point score for both tasks.

In the Table Setting segment, participants were asked to set a table for four guests by placing plates, forks, knives, and spoons in the appropriate locations on each placemat. In each given round, participants were instructed to set tables according to one of two table-setting rules: 1) *by guest*, meaning the complete tableware set should be placed for one guest before moving onto the next guest, or 2) *by tableware*, meaning each type of tableware should be placed at once for all four guests (i.e., set all four forks, then set all four knives, etc.). The program did not allow placement of a tableware in the wrong place. Table setting scores counted only fully set tables following the given instruction.

In the Cooking segment, participants were asked to cook two to five food items. To start cooking, participants had to press “start” under each food item displayed and press “stop” when they finished cooking each food. Cooking times were displayed in minutes for each item and are always the same throughout the training (coffee: 4.5, sausage: 3.5, pancakes: 2, egg: 1.5, and toast: 1 minute). Participants started each trial by starting the food item with the longest cooking time (i.e., the coffee). Ideally, each food item should be started and stopped at the accurate times so they all finished at the same time and could be served together. For the foods to be accurately cooked and for all items to be completed together, each subsequent food should be started when the time remaining for the foods being cooked was equivalent to the food’s cooking time, meaning that the cooking timer should be started for the longest food cooking time first and the shortest food cooking time last.

In some sessions, both the Table Setting and Cooking tasks were equally important toward scoring, and participants were therefore expected to divide their attention equally between tasks. In other sessions, however, EmCh was applied, and participants were

asked to prioritize one task over the other while playing the game. Under EmCh, participants received the instruction to pay special attention to one of the tasks and were told that 75% of their scores would be based on the performance of the emphasized task.

Intervention Design

The BT training design consisted of total five individual sessions delivered twice a week. Each session lasted approximately 45 minutes and was comprised of eight trials lasting 4.5 minutes each. Participants were asked to not play the game more than one time per day (the system prevent them to do it), and if possible, nor wait more than 4 days between sessions. Details of intervention design and session features are summarized on Figure 3.

Session 1 was supervised remotely, which allowed us to collect relevant information about participants' interactions with the web platform. Participants had to access the Zoom platform and share the screen with the researcher, who guided them to navigate the platform, including game instructions, 10-minute practice, and playing the game. The researcher observed participants' performance with video and audio off to avoid distractions and was available to clarify any aspects of the task between the trials. In session 1, participants learned to play the game with the tasks in the same screen. In session 2, for which participants had to access the game platform alone and play the game without supervision, the tasks began to be presented in separate screens (split mode). Participants had to press a button to switch between two screens and therefore track the two tasks alternately, imposing a higher cognitive load and increasing the difficulty of the game.

316 In session 3, the game difficulty increased, since participants had to deal with more
317 food items and apply EmCh manipulations to the game. Participants were instructed to
318 direct their attention to the Cooking task during session 3 as 75 percent of their scores in
319 each trial would be based on their performance on this task; the emphasis was shifted to
320 the Table Setting task in session 4 with the same instruction. During session 5, emphasis
321 alternated between the Cooking and Table Setting tasks depending on the trial. To ensure
322 clarity of EmCh instructions, session 3 was also supervised remotely through Zoom.
323 Sessions 4 and 5 had the same structure as session 3 but were not supervised; therefore,
324 participants had to apply EmCh when playing the game without supervision.
325 To reduce attrition and promote retention, the staff could be contacted by email to
326 discuss potential problems, and if necessary, a phone call or extra Zoom session could be
327 scheduled. Reminders were sent through email before every session. Session's
328 adherence and completion were monitored remotely through the game platform. In case of
329 reduced adherence, such as delay for completing a session within the period suggested,
330 we contacted the participant to identify the reasons and/or barriers and help identify
331 solutions.
332
333 **[Figure 3]**
334
335 *Game Measures*
336 Three outcomes were generated and presented to the participants after each trial:
337 1) *Number of Correct Tables*, or the number of full tables completed under the correct rule
338 (by tableware or by guest), with higher scores reflecting better performance; 2) *Cooking*

339 *Time Discrepancy*, the difference between the actual and required cooking time for each
340 food item (averaged across all foods); and 3) *Range of Stop Times*, the difference in stop
341 time between the first and last food item. For outcomes 2 and 3, units represent seconds,
342 and lower scores reflect better performance.
343
344 ***Implementation Outcomes***
345
346 *Feasibility*
347 Intervention feasibility was assessed through three outcomes: recruitment,
348 adherence, and retention. 1) *Recruitment:* We examined the recruitment rate, defined as
349 the proportion of approached participants that provided consent and those enrolled in the
350 study. Recruitment characteristics were described in order to understand potential barriers,
351 difficulties and interest of participants to be part of the study. 2) *Adherence and retention:*
352 Brief unsupervised remote cognitive training to older adults frequently shows high
353 adherence and retention rates, such as 80% to >94% (Bahar-Fuchs et al., 2017; Lee et al.,
354 2020; Simon et al., 2018). For the present study, we conceptualized intervention
355 adherence and study retention as 80%. Therefore, *adherence* was defined as attendance
356 of at least 4 of the 5 sessions within 4 weeks, and *retention* was conceptualized as the
357 proportion of enrolled participants who completed the study, including post-intervention
358 questionnaire.
359
360 *Acceptability*

Acceptability was assessed based on participants' quantitative and qualitative responses in the *post-intervention questionnaire*. They were asked to provide scores (0 to 10) and their views on specific issues within the BT. For instance, they were asked to provide scores on the difficulty of the game, clarity of instructions, and accessibility of the platform. They were also asked to rate how much they enjoyed the game and their overall experience in the study. Moreover, participants were asked to answer open-ended questions about the game and its influence on their daily life.

Game performance and analysis

Game performance was assessed through the scores recorded in each trial in all sessions. Session effect was assessed using a repeated-measures analysis of variance (ANOVA) for each game measure. The effect of EmCh instruction was assessed using one-way ANOVA by grouping trials under the same emphasis (Table Setting or Cooking tasks), regardless of the session. In addition, to compare the variance across games outcomes, we calculated the mean and standard deviation (SD) for each outcome based on the five sessions together and run a repeated-measure ANOVA. Based on these measures we also calculated the Coefficient of Variance (CoV = SD/Mean) for each outcome. Statistical analyses were performed using the Statistical Package for Social Sciences, version 26.

Results

Sample characteristics

The mean age of participants was 69.12 years old (SD = 3.83, range 60 to 75 years), and mean education was 17.66 years (SD = 3.03, range 12 to 25 years). Of the total recruited participants (*n* = 24), 75% were women (*n* = 18), and 95% were white. In addition, all participants were cognitively healthy with a mean MoCA score of 28.66 points (SD = 1.04, range 27 to 30 points) and lived independently, with a mean ADL-x score of 7.5 points (SD = .88, range 6 to 9 points). The main sample sources were the Columbia University *RecruitMe* research platform, an NGO working with older adults in Manhattan, and referral form research participants. Participants played the game with laptop or desktop, and all participants used a mouse while playing (smartphones and tablets were not used in the study).

Feasibility

Recruitment

Figure 4 outlines the progression of participants from recruitment to post-intervention data collection. Most participants were recruitment from the online platform RecruitMe and from an NGO located in Manhattan. From all 62 participants contacted, 58% (n = 36) responded to the initial email. It is worth mentioning that part of these participants was already in our contact list before the COVID-19 pandemic, so it is possible that this influenced the lack of responses. From those that responded to the initial email, 80.5% (n = 29) were eligible and consented to participate. Out of these 29 participants, five had to be excluded, resulting in a recruitment rate of 82.7% (24/29). One participant had difficulty with time availability to schedule the first session. The remaining four participants

had to be excluded after attending the 1st session due to technical demands, such as difficulties with Zoom platform (n = 2), mouse use (n = 1), and learning to play the game during practice (n = 1). Despite that, all 24 participants who attended the 1st session successfully completed the study. We considered our recruitment process to be feasible and could recruit >80% of the participants who were eligible and provided consent.

[Figure 4]

Adherence and retention

Our study showed 100% adherence and retention, since all participants that completed the 1st session completed the five sessions and the post-intervention questionnaire. The average amount of days between sessions was 3.3 days (SD=1.4, range 1 to 9 days), and the average time for completion of the study was 13.3 days (SD=5.6, rage 7 to 31 days).

Acceptability

Table 1 shows the responses on the post-intervention questionnaire. Most participants provided high scores when asked if they liked the overall concept of the game and considered the game to be somewhat difficult. Participants report low difficulty in accessing the game online, playing without supervision, and understanding the instructions. Most participants did not consider the game to be childish for their professional level, an aspect which could have interfered in their motivation. Responses were variable when asked if they wanted to continue to play this type of game, but ~ 70%

of participants provided scores above 6 when asked how much they enjoyed the sessions and how likely they would be to refer a friend or family member to the study. Participants provided very high scores for friendliness of the research staff, and ~ 80% of participants rated 7 or above for their overall experience in the study. In addition, participants provided their opinions about three open-ended questions: what they enjoyed the most, what was more challenging, and if the game had any impact on their daily life. A summary of these responses is presented in Table 2.

Game performance

The repeated measures ANOVA revealed a significant session effect for Number of Correct Tables [$F(1,23)= 10.80$, $p <.001$], indicating differences between all five sessions ($p <.05$) (Figure 5A). The number of tables successfully completed decreased from session 1 to 2, when the split screen mode was introduced, and again decreased from session 2 to 3, when more food items were included in the game. However, in sessions under similar difficulty level (session 3, 4 and 5), the performance linearly improved as a function of session. This trend was even more robust when we excluded sessions 1 and 2 and analyzed sessions 3 to 5 only [$F(1,23)= 27.53$, $p<.001$].

We did not observe a session effect on the Discrepancy [$F(1,23)= 1.76$, $p=.14$], but we observed a session effect on Range of Stop Times [$F(1,23)= 4.06$, $p=.004$] (Figures 5B and 5C, respectively). Similar to the pattern observed in the Table Setting task, there was a worsening in the performance from session 1 to 2 and from session 2 to 3 for both Cooking outcomes, and there was an improvement in the performance from session 3 to 5, with the best performance occurring in the last session.

It is worth mentioning that in comparison to the Table Setting task, both Cooking measures showed higher variance, particularly Discrepancy. There was a significant difference between variances across the game outcomes ($F_{(2,46)} = 25.37$, $p < .001$), with Table Setting significantly more homogeneous (CoV = 0.022) than RST and Discrepancy (CoV's = 0.76, 0.85, *p*'s = <.001, .03, respectively).

[Figure 5]

Regarding EmCh instruction effect, we observed a significant effect of emphasis instruction on Number of Correct Tables [F(1,575)= 27.62, p <.001]. As expected, better performance on the Table Setting task occurred when emphasis was placed on the Table Setting task. However, there was no emphasis instruction effect on Discrepancy [F(1,575)= 1.28, p =.59] or Range of Stop Times [F(1,575)= 1.54, p =.69].

Discussion

The present feasibility study is an initial step in the development of an evidence-based theory-driven cognitive training approach for cognitively healthy older adults. Our pilot data showed that the web-based training platform, the Breakfast Task Training, is feasible in older adults, and the intervention procedures were reported to be acceptable by the participants.

Our results showed overall high recruitment (82.7%), adherence, and retention (100%) rates of the online 5-session protocol. These findings align with those of previous studies conducting brief unsupervised remote cognitive training to older adults, reporting

high adherence and retention rates, such as 80% to >94% (Bahar-Fuchs et al., 2017; Lee et al., 2020; Simon et al., 2018).

Regarding the game performance, our analysis revealed a learning curve across the sessions, an encouraging observation for a future definitive trial. During the Table Setting task, participants significantly improved their performance, especially across sessions of the same difficulty level. This pattern was also observed on the Cooking task outcomes, albeit only at the trend level since the effect was not significant. The fact the participants considered Cooking task to be harder than the Table Setting task may have influenced this result, and it is likely that additional practice is necessary to show improvement in both tasks, especially within the Cooking task (Gopher et al., 2022). It is promising that the participants were responsive to EmCh instructions, although its effects were significant for the Table Setting task only. In this feasibility study we applied EmCh in three sessions, which may have not been enough to produce observable effects in both tasks. In a future definitive trial, dose needs to be carefully planned, and additional sessions will allow us to further understand the task learning as well as the EmCh effects in both tasks.

The fact that EmCh manipulation was effective on Table Setting but not on the Cooking is consistent with a previous work with young participants (Gopher et al., 2022). It is possible that the low variance in Table Setting and the high variance in the Cooking outcomes may have contributed to this finding. The nature of load is very different in Table Setting compared to Cooking, since in the Cooking task there is an embedded conflict between Discrepancy and Range of Stop Times. As no preference instructions were given between the Cooking task rules, participants may have oscillated between the two rules in each round. As a result, we suggest there is already an emphasis decision within each

Cooking task trial, which may have difficulted the participants to cope with the emphasis instructions between Cooking and Table Setting tasks. We believe the consequence of this is the very large CoVs observed in the Cooking task outcomes. For future trials we should carefully review this aspect in order to enhance efficiency of EmCh approach.

It is relevant that participants reported little difficulty in accessing the game online without supervision and in understanding the game instructions. This shows that we were successful in our approach to teach the instructions of the game and how to use the platform at home. In addition, these perceptions are consistent with the high adherence and retention rates of the study. Participants' responses indicated they liked the concept of the game, and most participants provided medium to high scores when asked if they enjoyed the game and about their overall experience in the study. Some participants reported enjoying competing against themselves and observing their improvement across sessions. Despite that, the responses were variable when asked if they wanted to continue to play this type of game. This is a relevant aspect that should be considered for a future definitive trial. It is possible that some of the technical difficulties and repetitiveness reported may have influenced how much participants enjoy the sessions. Future definitive trial using the Breakfast Task platform should consider structuring the sessions in a more dynamic way, with less repetition across rounds within the same session, advancement of the technical issues reported in this first pilot study.

It is worth mentioning that the BT is cognitively demanding and involves executive control in high load, which is a close simulation of many daily tasks. Therefore, the fact the platform involves an ecological training brings good prospects to its future transfer value. This was reflected in some of the participant`s qualitative responses after the training, such

522 as feeling they could “concentrate/focus more”, “figure out how to do repetitive tasks with
523 least boredom” and “think more about what is important when dealing with multiple tasks”.
524 Despite the general good feasibility and acceptability of the BT, difficulties and
525 limitation were noted and should be considered. This study was conceptualized before the
526 COVID-19 pandemic and was adapted to become remote, so the recruitment strategy was
527 originally designed for a remote study. It is worth mentioning that most of our participant
528 source came from a specific NGO and *RecruitMe* platform during the pandemic, which was
529 not the ideal approach to recruit a diverse sample, since 95% of the sample was white.
530 Future trials should consider an active recruitment strategy in specific communities to
531 better represent minorities.
532 Although most participants recruited did not have difficulties using a computer with
533 internet and the Zoom platform, these technical demands were the main reason for
534 participants to be excluded from the study after the first session. Other source of difficulties
535 stemmed from the technical demands of the game. For instance, during the Table Setting
536 task, participants reported issues when dragging or dropping utensil items (details on
537 Table 2) and considered the space to place the utensils too small, which required higher
538 motor control than usual mouse use. It is likely that these technical aspects of the game
539 may have contributed to a less unjoyful experience since it added distractions, and
540 difficulties to play the game. In addition, some participants reported the task design was
541 repetitive, which may have caused some tediousness and contributed to the light soreness
542 in the hand/arm. All these game issues should be carefully reviewed and improved for a
543 future trial. Although most of the session’s attendance happened within the study
544 framework, as the average between sessions was 3.3 days, on some occasions

545 participants needed to wait longer periods (> four days) between sessions, with a
546 maximum of nine days in one case. This variability in the inter-session interval may
547 happen in any intervention study, and it has the potential to influence intervention
548 response. Additional strategies such as additional reminders are relevant to engage
549 participants in the study framework.

550 In conclusion, the present feasibility study has generated relevant pilot data about the
551 BT training in cognitively healthy older adults and is a promising intervention tool to be
552 incorporated in future trials. It is worth mentioning this is a first step to assess feasibility
553 and acceptability in older adults, and this study was not designed to access efficacy of the
554 proposed training platform. Additional studies are necessary to better understand efficacy
555 of using the BT training platform and EmCh approach. One of the advantages of the BT
556 platform is its ecological approach and flexible interface which allows adaptation of the
557 task difficulty, instructions, dose, duration, and frequency. While the 5-session format was
558 enough to provide initial feasibility, acceptability, and adherence/retention, longer
559 intervention format and control design are necessary to investigate the potential benefits of
560 BT training effects in older adults, including the game outcomes and transfer effects.

561

562 **Declarations**

563 **Ethics approval and consent to participate**

564 The study protocol and documents were reviewed and approved by the Internal
565 Review Board of the College of Physicians and Surgeons of Columbia University
566 (reference: IRB-AAAS6529). Online written informed consent to participate was obtained
567 from each participant through a secure electronic signature system.

568 **Consent for publication**

569 Not applicable

570

571 **Availability of data and materials**

572 The datasets used and/or analyzed during the current study are available from the

573 corresponding author on reasonable request.

574

575 **Competing Interests**

576 The authors declare that they have no competing interests.

577

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581

582 **Authors contribution**

583 DG and DD design the Breakfast Task platform. YS, DG and SSS design the feasibility

584 study protocol. SSS and MP implemented the study steps and collected the data. SSS

585 analyzed the data. DG, DD, YS and SSS interpreted the data regarding the intervention

586 results. SSS and MP were major contributors in writing the manuscript. All authors read

587 and approved the final manuscript.

588

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590 Not applicable.

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Figures and Tables

Figure 1. Study design

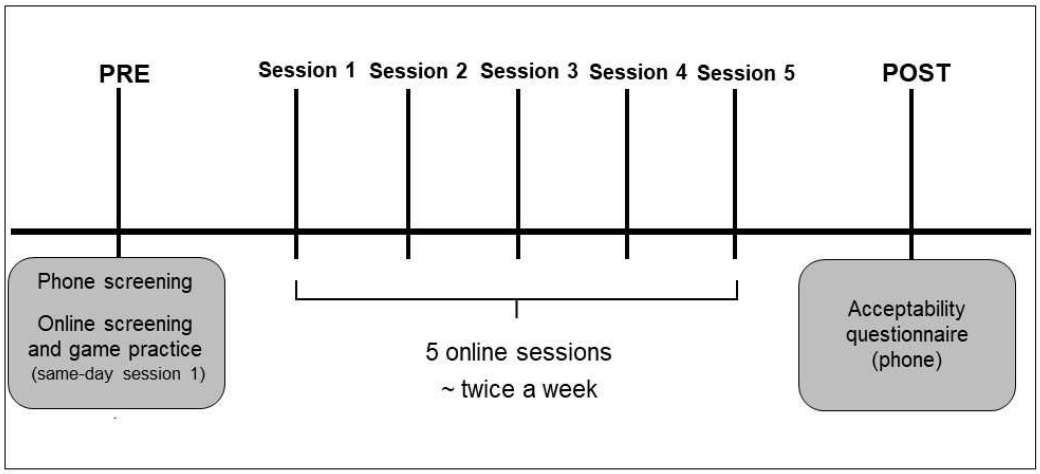


Figure 2. Breakfast Task platform

Legend: Breakfast Task training showing both tasks in the same screen. On the left side, the Table Setting task: the table and four guests seats are displayed with space for plates and utensils. Each participant must set the tables by guest or tableware rule. On the right, the Cooking task: food items are displayed with the cooking time in minutes and seconds and illustrated with bars. Participants must press “start” to begin cooking and “stop” to

Figure 3. Training Design and Features

Session 1 (Supervised) no EmCh	**Session 2** (Unsupervised) no EmCh	**Session 3** (Supervised) EmCh on Cooking	**Session 4** (Unsupervised) EmCh on Table	**Session 5** (Unsupervised) EmCh on both
Tasks on same screen TS rules: 4 trials by guest, 4 by tableware Cooking: 2-3 items	Tasks on different screens TS rules: 4 trials by guest, 4 by tableware Cooking: 2-3 items	Tasks on different screens TS rules: Random (guest or tableware) Cooking: 5 items	Tasks on different screens TS rules: Random (guest or tableware) Cooking: 5 items	Tasks on different screens TS rules: Random (guest or tableware) Cooking: 5 items

Legend. EmCh: Emphasis Change; TS: Table Setting

Figure 4. CONSORT flowchart for selection of study participants

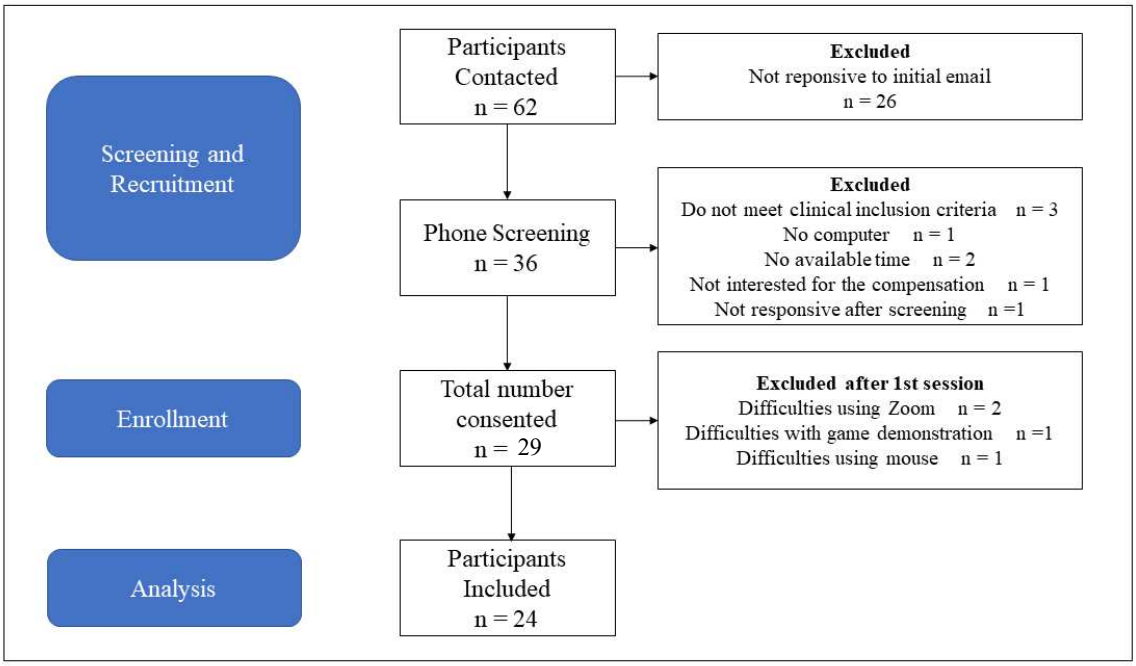
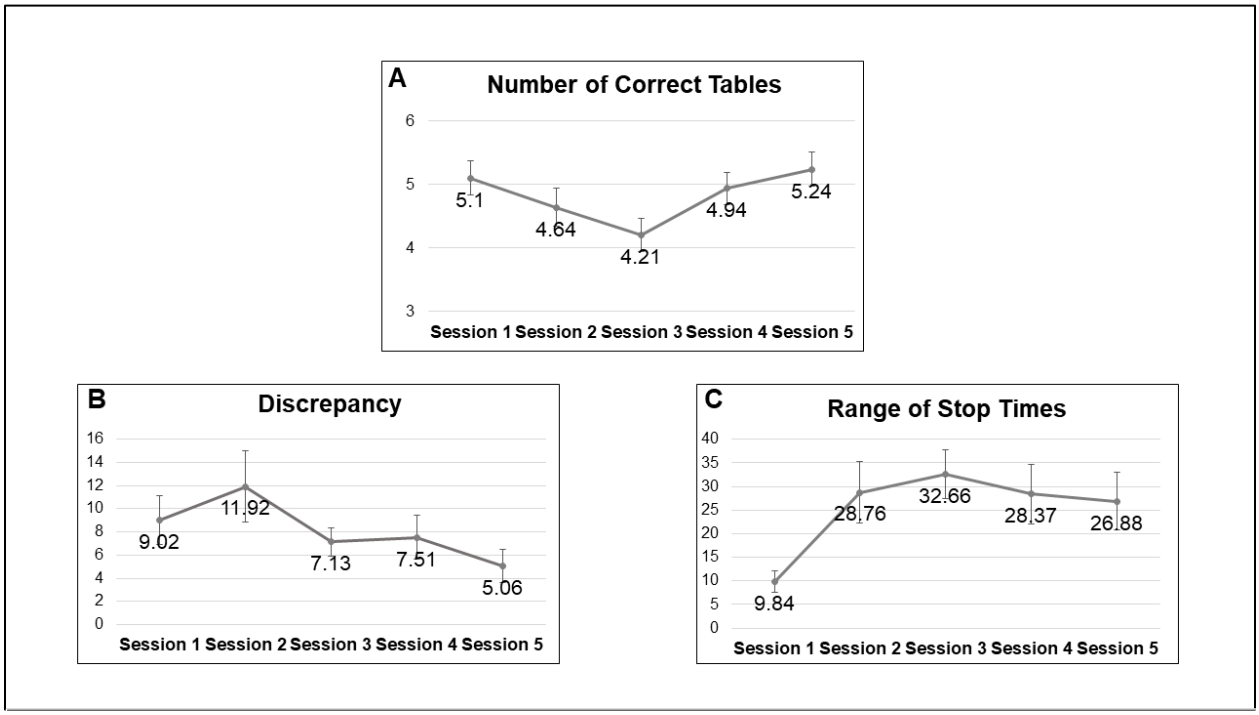


Figure 5. Breakfast Task performance across sessions



Legend. A: higher values represent better performance; B and C: lower values (sec.) represent better performance

Table 1. Post-Intervention questionnaire to examine program acceptability

Acceptability Questionnaire	Mean (SD)
1. How much did you like overall concept of the Breakfast Game?	7.79 (1.86)
2. How difficult was the game for you? Which part was particularly difficult?	4.55 (2.16)
3. How difficult was to access the game by yourself (without supervision)?	0.45 (0.88)
4. How difficult was to play the game without remote supervision?	0.37 (0.82)
5. How difficult was to understand the instructions?	0.66 (1.27)
6. How much do you feel the training was too childish for your professional level?	2.62 (3.00)
7. How interested would you be to continue this type of game?	4.95 (3.66)
8. Overall, how much you enjoyed the sessions? Which part you enjoyed the most?	6.91 (2.08)
9. How likely would you be to refer a friend or family member for this study?	7.00 (2.94)
10. How friendly was our staff (How well did we treat you)?	9.79 (0.50)
11. How would you rate your overall experience in the study?	7.91 (1.71)

Table 2. Perceptions about the program

What did you enjoy most?	What was challenging?	Impact on daily life?
. Table setting . Setting by either rule . Timing tables with food . Enjoyed seeing how many table could be made . Testing/competing/challenging against self . Challenge of meeting time	**Technical issues** . Accidentally highlighting table when trying to drag a utensil . Difficult/clunky to drag & drop utensils precisely . Small space to place utensils, motor difficulties . Instruction text could be bigger **Repetitiveness/tediousness** . Repetition of thumb movement . Hand/arm soreness . Repetition of same difficulty level **Others** . Remembering table rule . Meeting cooking time . Feeling anxious to deal several information . Understanding scoring	**Mostly no** **Positive responses:** . Improved performance on othe online game . Concentrating/focusing more . Figure out best way to do repetitive tasks with least boredom . Thinking more about what is important when dealing with multiple tasks

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CONSORTextensionforPilotandFeasibilityTrialsChecklist.doc